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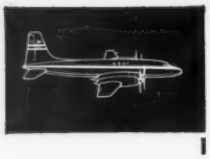

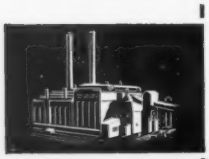

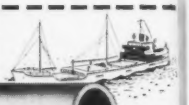

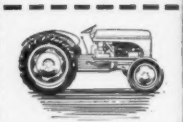

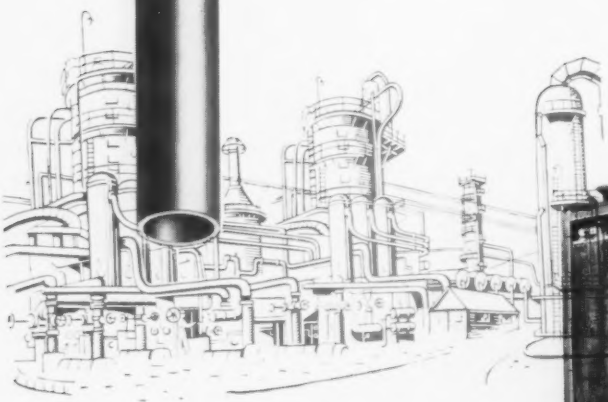

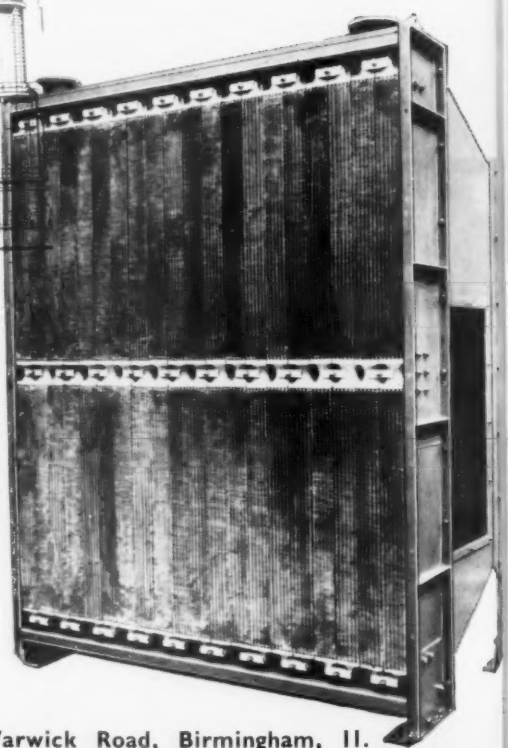

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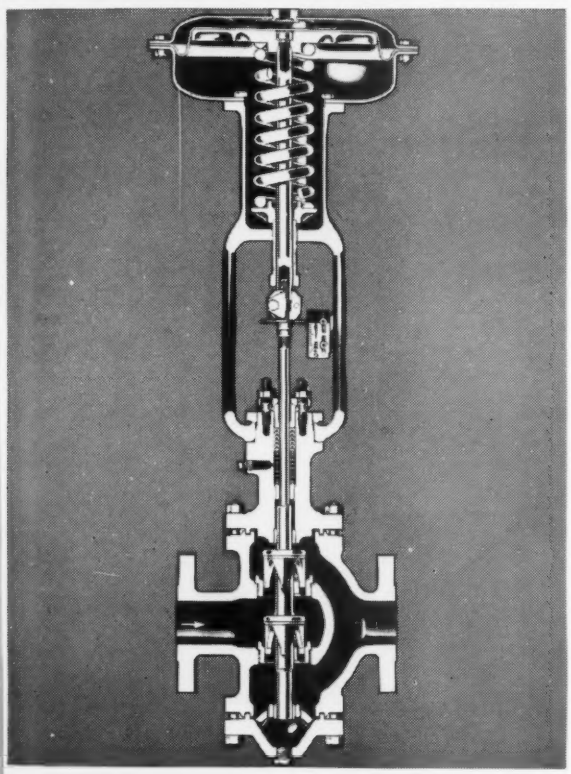

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Published monthly by
THE INSTITUTE OF PETROLEUM
26 Portland Place, London, W.1
'Phone: LANgham 2250

Vol. 11, No. 122 **February 1957**

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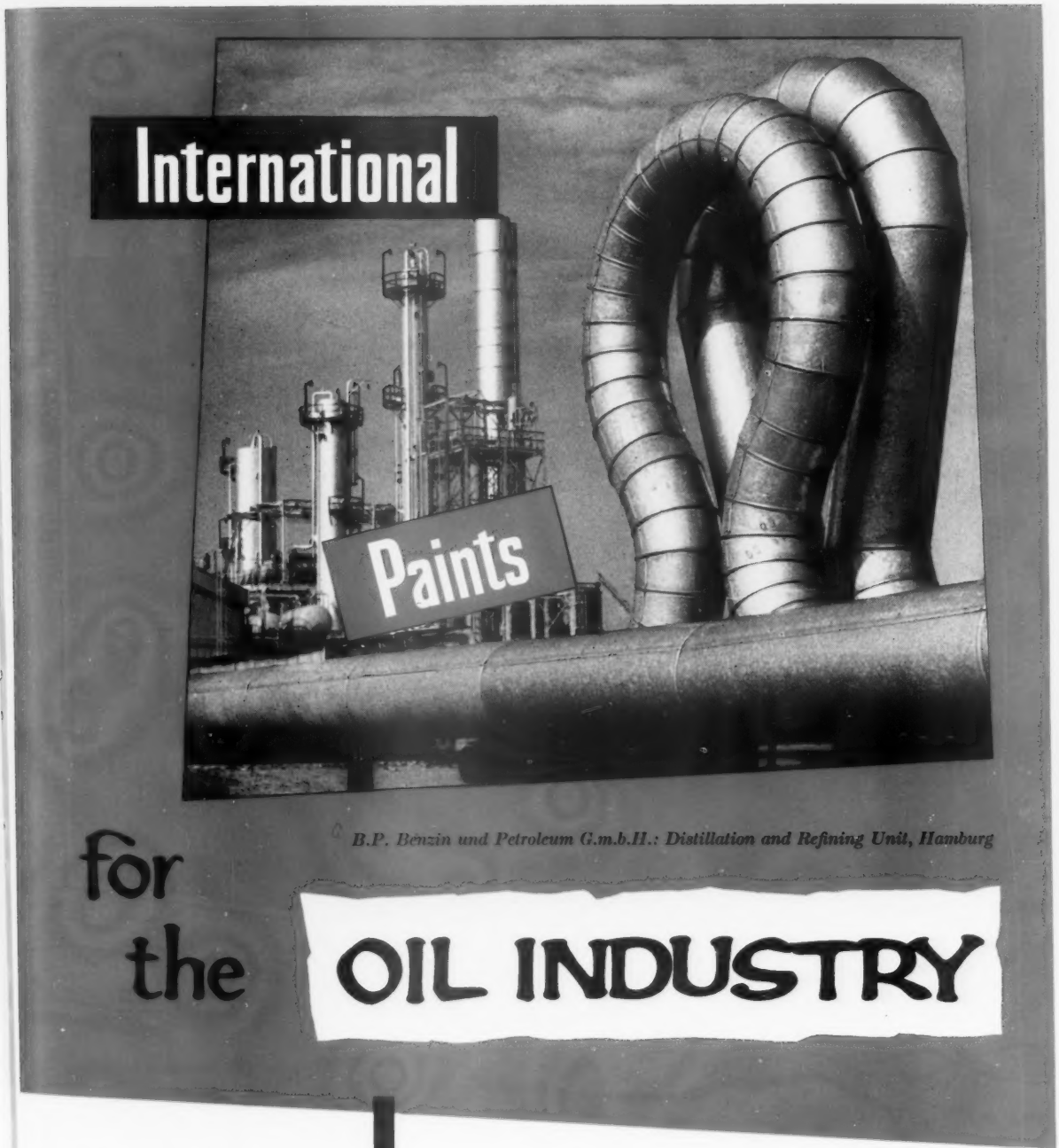

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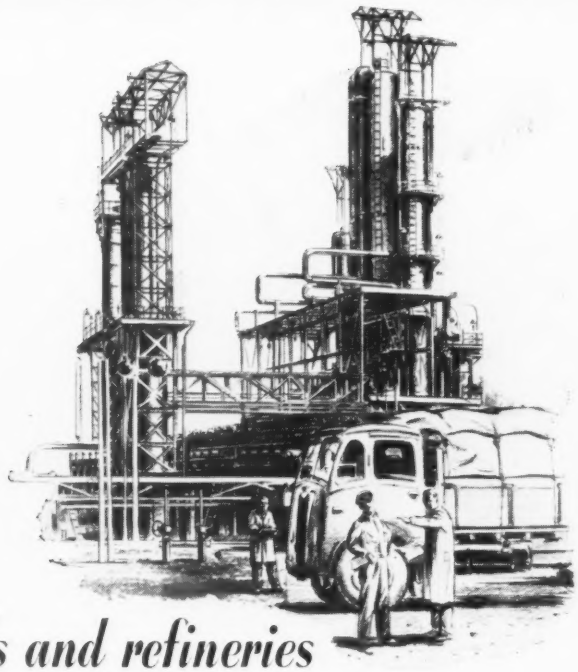

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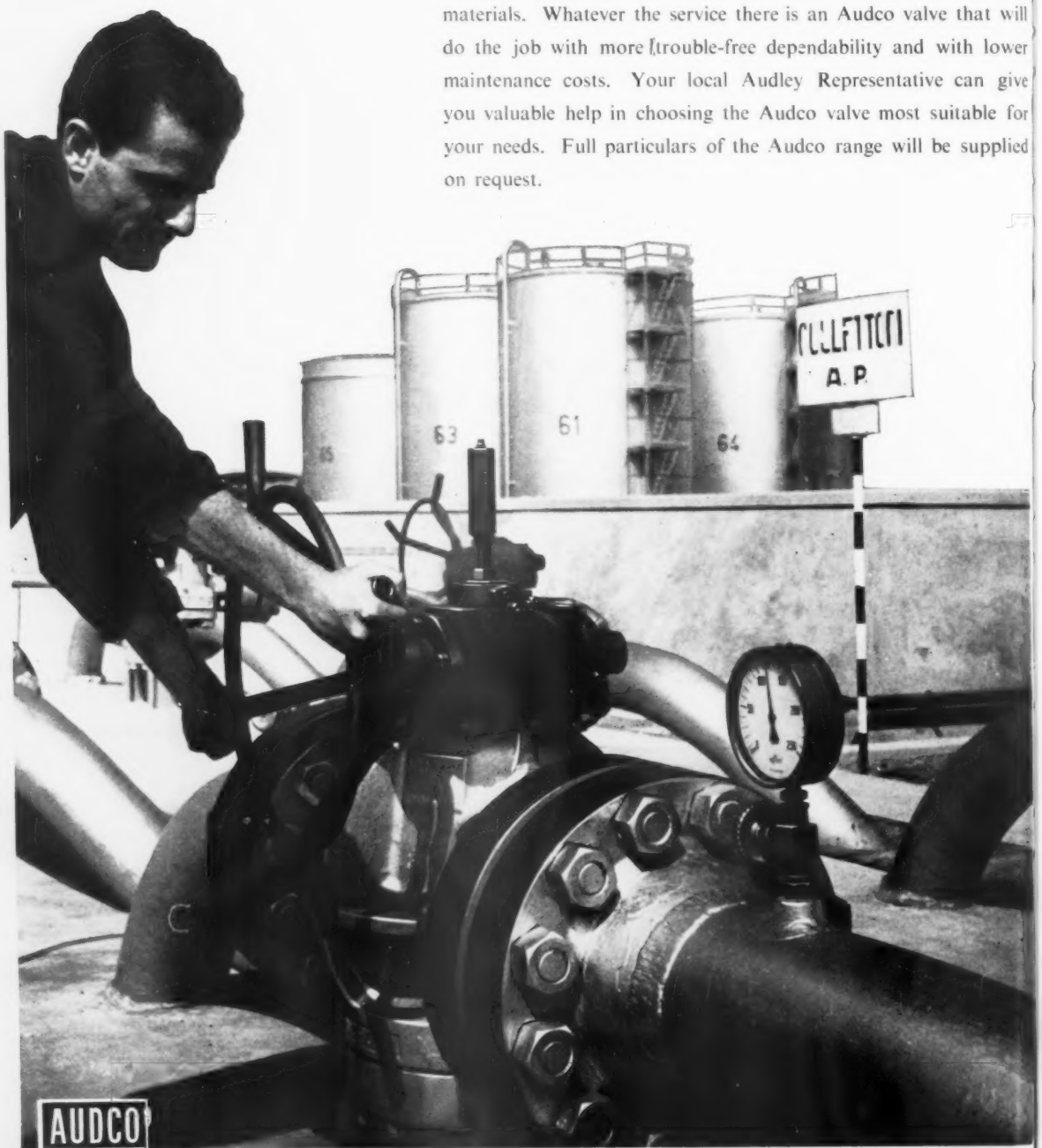

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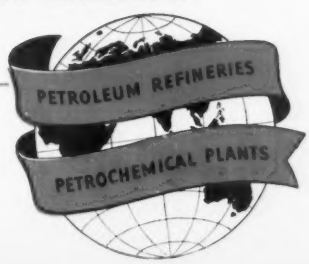

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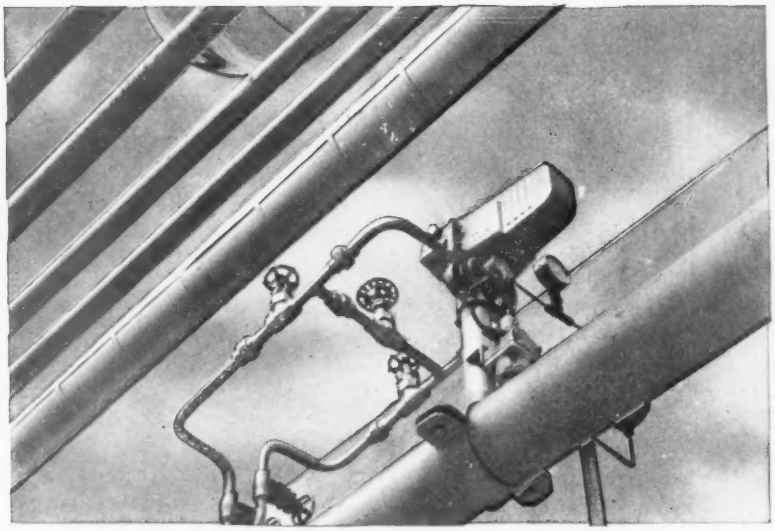

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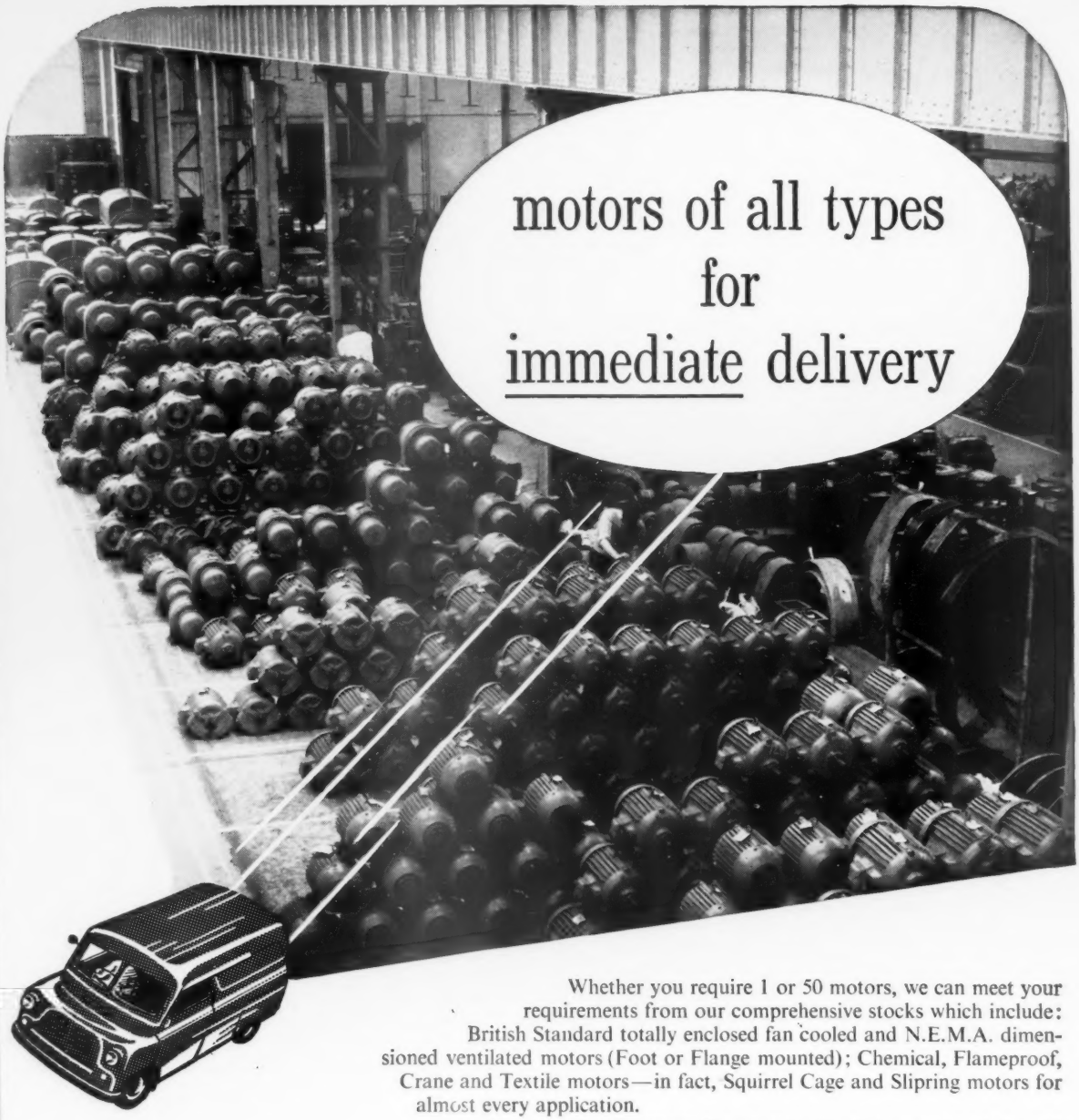

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REVIEW

Volume 11, No. 122 February 1957

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The Netherlands Petroleum Industry

Operations of the BPM Described

The major oil company in the Netherlands is N.V. De Bataafsche Petroleum Maatschappij, which is concerned in all phases of the petroleum industry from exploration and production to refining and research. The BPM, as the Company is widely known throughout the Netherlands, is of more than passing interest to Britain as it is 40 per cent owned by the "Shell" Transport and Trading Company Ltd. When the Royal Dutch and the Shell interests were definitely amalgamated in 1907 two new companies were formed—the BPM to undertake exploration and production and the Anglo-Saxon Petroleum Company Ltd to be responsible for transport and storage interests, their capital being held as to 60 per cent by N.V. Koninklijke Nederlandsche Petroleum Maatschappij (The Royal Dutch Petroleum Company) and 40 per cent by the "Shell" Transport and Trading Company Ltd. The marketing interests had since 1903 been vested in the Asiatic Petroleum Company Ltd (now The Shell Petroleum Company Ltd).

As the result of a structural simplification carried out during 1955, whereby the business of the Anglo-Saxon Petroleum Company Ltd was vested in the Shell Petroleum Company Ltd, the number of parent operating companies has been reduced to two. These two companies, in their turn, have investments in a large number of other companies. Together all these companies are known as the Royal Dutch/Shell Group of companies, or "the Group" for short.

This great Netherlands-British combination has expanded into every sphere of the petroleum industry in most countries of the world. The relationship of the basic components of the Group is shown in the following chart:

N.V. Koninklijke Nederlandsche Petroleum Mij. Founded 1890
The "Shell" Transport & Trading Co Ltd. Founded 1897
N.V. De Bataafsche Petroleum Mij. Founded 1907
The Shell Petroleum Co Ltd. Founded 1903 as the Asiatic Petroleum Co Ltd.

Having shown the position of the BPM in the scheme of the Royal Dutch/Shell Group, it is now proposed to describe —necessarily briefly—some of the BPM activities in the Netherlands as observed during a recent visit.

Research

Research embracing all aspects and phases of the petroleum industry has long been a keyword of the Group. This is evident from the fact that while in 1919 the total research staff

Research
Part of the Royal Dutch/Shell Laboratory at Amsterdam.

Production
An exploration well being drilled by NAM.

Refining
Part of the BPM Pernis refinery with No. 1 cat cracker in the foreground.

of the Group throughout the world numbered only 25, the present total is over 5000.

To-day the Group has fourteen research centres, their work being co-ordinated to provide one of the largest scientific research organizations in the world.

Not the least of the research laboratories is that at Amsterdam, where a staff of over 1800 persons is continuously engaged on problems relating to petroleum. In general the work is divided into three main groups. The first group concerns problems relating to the oil industry itself, the second deals with chemicals from petroleum, and the third with fundamental scientific research.

The general principle in all research problems is that after the matter has been studied from a fundamental point of view it is then passed to the applied research section. Then, if results are satisfactory, the process development department takes over and in this phase there is close co-operation with the BPM Head Office in the Hague.

An interesting feature of the organization of this laboratory is that all research staff are allowed to spend 10 per cent of their working time in developing independent ideas that may occur to them. This provides an opportunity for individual initiative and has resulted in considerable benefit to the Group.

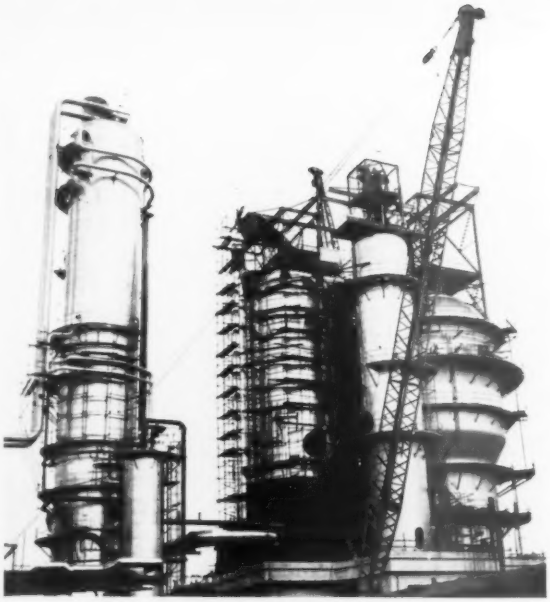
Oil Research

The work of this group is concerned with three main sets of problems: those connected with exploration and production methods; those relating to processing; and those of research on and development of products.

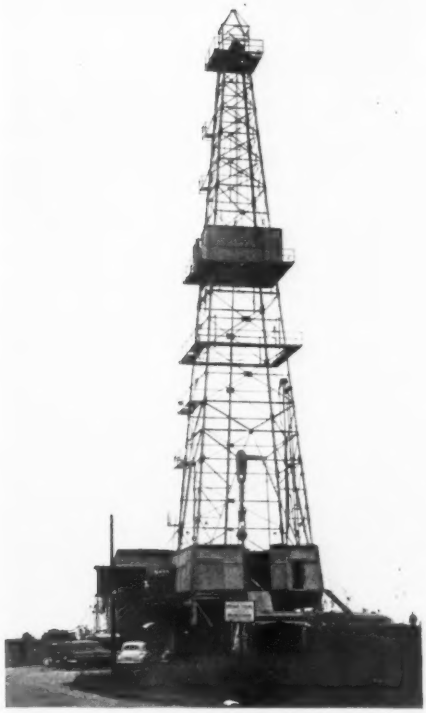
Exploration and Production

Probably the most important problem of the industry is to produce the maximum quantity of oil from that originally present in the oil-bearing strata, and special attention is paid at Amsterdam to the flow characteristics of gas, oil, and water through porous media.

Existing methods of draining an oil-sand are constantly being studied with a view to improvement, and new methods for increasing recovery are given special attention. In many reservoirs the yield can be increased by water injection into the porous formation through carefully selected injection wells. The water assists in driving the oil towards the wells, but, if the oil viscosity is high, the efficiency of this process is low. This efficiency could be improved by using hot water instead of cold, and this is being investigated in the laboratory. Another interesting possibility of increasing the ultimate recovery from an oil reservoir is to burn some of the oil *in situ* to produce hot gases which would heat the remainder of the oil, reducing its viscosity and driving it towards the wells.



Catalytic cracker No. 2 under construction and forming part of an impressive expansion programme.



A deep test well being drilled in the Schoonebeek field.

To improve the efficiency of drilling, drilling muds and cements are the subject of investigation.

Some of the laboratory work is ultimately the subject of large-scale experiments in the Schoonebeek oilfield, about which more will be said later.

Processing

The study of processing methods, old and new, is carried out first in laboratory scale apparatus and later in pilot plants. Many well-known processes have been evolved in the Amsterdam laboratories, and it was here that the alkylation process for high-octane aviation gasoline was discovered and developed. Among other processes developed in Amsterdam is the "trickle" hydrodesulphurization process for gas oil. This is particularly important in the removal of sulphur from Middle East diesel and gas oils, and it is interesting to note that the gaseous hydrogen required for this process is now obtained from the platforming process.

Unit operations such as blending, heat transfer, etc., in the refinery are the subject of special study, as also are the design of apparatus and the selection of materials of construction. In the latter connexion a special materials group devotes itself to the study of corrosion. This very important subject is treated in the widest sense, consideration being given to all oil industry equipment whether for production, pipelines, tankers, refining plant, or any other use.

Dock facilities at Pernis can accommodate large ocean-going tankers such as the World Sincerity *seen here in the dock.*

Oil Products

Research on the properties of a wide variety of petroleum products in relation to their composition and to the purpose for which they are to be used is of considerable importance. All types of modern equipment are employed in Amsterdam for studying the structure and properties of the products, and special methods and apparatus for analysis and separation are devised for special investigations.

Locally known as a "yes-nodder"—a pumping well in Schoonebeek.

For testing fuels and lubricants in all types of prime movers, a well-equipped engine laboratory is in constant use.

Chemicals from Petroleum

The wide range of chemical base materials which can be obtained from petroleum is the subject of careful investigation in this section of the laboratory. Much development has been carried out here, for example, on the preparation of synthetic detergents, of solvents from olefins and of plastics (polyvinyl chloride). In recent years the development and application of epoxide resins ("Epikote" for surface coatings) has had the attention of the Amsterdam Laboratory. Several of the above mentioned developments have led to the erection of commercial plants in the Group.

In the biological field, the laboratory has collaborated with other Group research centres in the development of agricultural and horticultural insecticides and fungicides. More recently much of this work has been transferred to the new Agricultural Research Centre at Woodstock, in Kent.

Basic Scientific Research

With the growth of specialization it has become essential that industry should itself participate in fundamental scientific research, most of which was formerly undertaken by the universities. In Amsterdam this section is housed in a modern building fully equipped with the most up-to-date apparatus. Here a team of specialists concern themselves with problems of mathematics, theoretical chemistry and physics, new chemical reactions, catalysis, and pass their results on to the applied research section for consideration for possible use in the manufacture of new products or the improvement of existing processes.

In order to avoid any hold-up of work owing to the time required for calculations, the BPM about a year ago installed a new electronic computer built by Ferranti Ltd, known as "Miracle". This robot can perform in a few seconds a calculation which would take months to complete by any other method.

Petroleum Production

It was not until 1935 that the BPM turned its attention seriously to the possibilities of finding petroleum in Holland. In that year a geological survey was undertaken in the north-eastern provinces and continued until the outbreak of war in 1939. In 1943 some production in the Portlandian was shown to exist in a well 7·5 km east of Coevorden. Shortly after, oil was found in the Valendis sand in the Lower Cretaceous at Emlichheim in Germany and, in July 1944, in well No. 3 at Schoonebeek. Fortunately, this discovery was too late for the enemy to take advantage of it.

Once hostilities ceased the exploratory and development work continued, and in 1947 a new company was formed as a joint venture of the BPM and the Standard Oil Company (New Jersey), each holding a 50 per cent interest. The management of this company—N.V. Nederlandse Aardolie Maatschappij (NAM)—is in the hands of the BPM at The Hague, and day-to-day administration is the responsibility of the NAM at Oldenzaal.

In 1953 a new oilfield was discovered on the Rijswijk Concession, near The Hague, and in 1954 commercial production was found in a well near Delft.

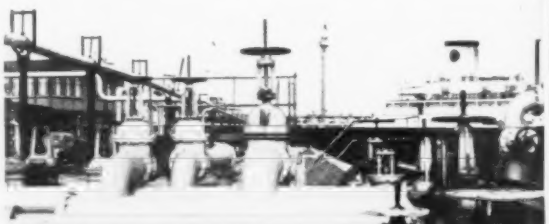
Together, the Schoonebeek and Rijswijk areas produce about one million metric tons per year and provide about 25 per cent of Holland's present oil requirements, production from the latter area making up for the normal decline in output from Schoonebeek.

Crude petroleum from the two areas is similar in characteristics. It is of paraffin base, sulphur-free, with a high wax content, and having a specific gravity of about 0·905 (27·5 API).

Schoonebeek

Production is by pumping, and the producing sand is an excellent one with porosity of up to 33 per cent and permeability averaging 5000 millidarcys and rising to 15,000 mD locally. Depth of the producing sand is 2500 to 3000 feet and its thickness varies from 16 to 130 feet. It covers an area of some 9½ square miles. Gas:oil ratio is about 45 cu.m/ton of oil and water: oil ratio is approximately 2½:1.

Total oil production is at present about 2900 metric tons per day, the quantity of salt water being about 7500 tons. All



Masses of pipes and valves connect the petroleum dock with the storage area at Pernis.

this salt water is returned to the strata after separation and treatment and is used to assist further oil production.

At the time of the visit on which these notes were prepared, 267 of the 297 wells drilled specifically for oil were in production, and well No. 313 was being drilled as a deep test to about 10,000 feet and to test a possible gas zone in this area. Only 26 wells had been dry-holes, and in addition 15 wells had been drilled as water-injection wells for secondary recovery.

In this field various methods of secondary recovery are being tried out or under study, including those previously referred to as being investigated in the BPM laboratories at Amsterdam. These include water injections on the flanks of the field, gas injection above the oil zone in the central part of the field, injection of hot water at about 200° C, and the partial combustion of oil *in situ*.

Schoonebeek crude is conveyed to the refinery at Pernis by rail tank car, two trains per day being used, each carrying about 1200 metric tons. Journey time is 18 to 19 hours compared with about 3 hours for a normal passenger train.

Western Area

In the Rijswijk concession, near The Hague, oil was first found in 1953, and in 1954 a commercial strike was made in the vicinity of Delft. Early in September 1956, a well at Wassenaar came into production with a yield of about 600 barrels per day, the largest individual well output up to that time. Average depth of the producing strata is 3000 feet.

In 1953, the Western area produced about 0·3 per cent of Holland's total crude oil output, in 1955 about 8 per cent, and it has now risen to about 13 per cent. The crude oil is conveyed to Pernis refinery in tank barges.

Natural Gas

There is a considerable production of natural gas by NAM and this amounts to about 10 per cent of the country's total consumption to-day. Natural gas was first found at Coevorden in 1948 and since then has been discovered at various places, including De Wijk and Staphorst in the Zwolle area, around Groningen, at Tubbergen and Denekamp in Overijssel, and latterly near Noordwijk on the west coast.

In 1953 the NAM guaranteed to supply 14 million cubic feet of gas per day for twenty years, and the State laid a network of pipelines in the north and east of Holland to deliver the gas to consumers. The distribution systems will be extended to the north-west later.

The gas has a calorific value of about 8400 calories and is produced at pressures of up to 300 atm. After treatment in a high-pressure separator, the pressure is further reduced to 40 atm for transmission by pipeline to main distribution centres.

Refining

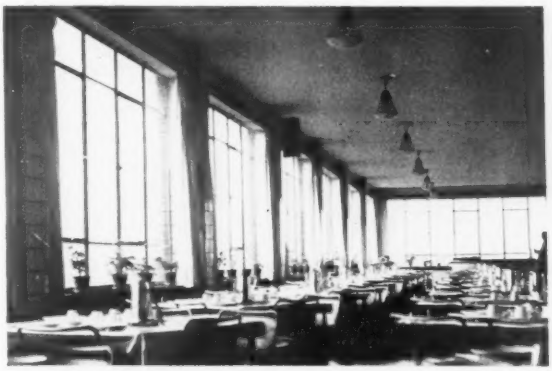
The refining activities of the BPM in Holland are centred at Pernis 10 miles from Rotterdam and 15 miles from the sea on the New Maas river. Here is the largest refinery in Europe, covering an area of 900 acres, it has a crude intake of 12 million metric tons per year, and facilities for handling the largest tankers at present envisaged. Even now additional refining facilities are being installed and there is an area of 100 acres available for further expansion.

Dock facilities include two petroleum docks with four miles of quayside where eleven supertankers can be moored at once and crude can be off-loaded at the rate of 15,000 metric tons per hour. Average number of ocean-going tankers loaded and unloaded is 150 per month and, in addition, some 1400 to 1500 small ships for coastal and inland water traffic are dealt with monthly. The municipality of Rotterdam has a third petroleum dock under construction to the west of the Old Maas river, and further petroleum installations are to be built in this area. It has been announced that the Standard interests are to erect a 2 million ton per year refinery here and that Caltex may build storage facilities.

Refining Facilities

Pernis refinery produces a full range of petroleum products, including chemical base materials and chemical products.

Over 20 types of crude petroleum are handled in this refinery, many of which come from the Middle and Far East, Venezuela, and Colombia. As already mentioned, Holland's indigenous oil is also refined here and the portion owned by the Standard interests is finished to meet their requirements.



The well-appointed staff canteen in Pernis refinery.

Extensions recently completed include a second fluid-bed catalytic cracking unit which came on stream in November. This was under construction at the time of the visit and it was interesting to note how the work had been simplified by the use of a 1:50 scale model of the unit and its two ancillary-vacuum-distillation plants and gas treater. Made of wood, plastic, and copper wire by Industrial Models N.V., these models not only simplified pipeline and lay-out problems but will also serve in the training of staff for operational duties.

Owing to the soft nature of the ground it is necessary for all plants to be erected on preformed concrete piles, 80 feet in length for the heavier structures and 60 feet for smaller plants.

In the erection of storage tanks, which at Pernis have a total capacity of at least three million tons and number over 1000, a $1\frac{1}{2}$–2 metre mound of sand is first constructed with a diameter slightly larger than the tank. The bottom plates are then laid and when the first course and bottom plates have been welded, an external angle iron is fitted on account of ground conditions. Erection then continues as usual. In the event of settlement, it is not difficult for the tank shell to be supported while additional sand is placed underneath.

Packaging

A special feature of the Pernis refinery is that no packaged product is carried more than 100 yards from the packing point to train or ship. All packing facilities are in close proximity to quayside, railway track, or loading bay.

Automatic filling devices are also much used. For example,

LPG can be weighed and filled into containers at the rate of 2200 containers per hour. Also, in the lubricating oil loading bay four thousand 44-gallon drums can be filled in each 8-hour shift, using 16 weighing machines in groups of four, each group being operated by one man. At no stage are bottles or drums touched by hand.

Labour Relations

Over 4500 men are employed in the Pernis refinery, and at any time there may be as many employees of contractors on the site.

Relations between BPM and its employees are excellent. All jobs in the refinery are classified, and any worker has the right to ask for his classification to be reconsidered.

Except for workers who live in South Rotterdam, employees are expected to find their own way to the refinery gates. From there they are conveyed to and from their place of work in open motor conveyances. The need for this is obvious when it is stated that there are at least 40 miles of road within the refinery area.

The canteens are clean, bright, and comfortably furnished and utensils are provided for the men who bring their own food. Hot coffee is available free of charge.

Acknowledgment

The notes on which this account of a great industry is based were made during a visit in September last to the installations described. The Editor is indebted to N.V. De Bataafsche Petroleum Maatschappij and The Shell Petroleum Company Ltd for the many courtesies and facilities provided during this visit, and to the various members of the staff who were extremely helpful.

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Her Majesty's New Year Honours

C.B.E.

Eric John Sturgess, A.C.G.I., B.Sc., A.M.I.Mech.E., F.Inst.Pet., chief engineer, Shell Petroleum Co Ltd, and a Vice-President of the Institute. Mr Sturgess was first elected to the Council in 1948 and became a Vice-President in 1955. He has been chairman of the Engineering Committee since 1948.

He joined Asiatic (now Shell) Petroleum Company in 1925 and served in Singapore until 1937. On returning to England he joined the Company's London office, and in 1947 became chief engineer, his present position.

E. J. Sturgess, C.B.E.

C. M. Cawley, C.B.E.

Charles Mills Cawley, O.B.E., D.Sc., Ph.D., F.R.I.C., A.R.C.S., D.I.C., F.Inst.Pet., deputy chief scientific officer, Department of Scientific and Industrial Research, a member of Publications Committee and of the Papers Sub-Committee from 1948 to 1952.

Peter Lloyd, deputy director, Research and Development, National Gas Turbine Establishment, Farnborough, Hants.

Captain William Gregson, R.N.R. (Engineer Branch), M.Sc. (Eng.), M.I.Mech.E., M.I.N.A., M.I.Mar.E., chairman, Fuel Efficiency Advisory Committee.

Lewis Luxton, O.B.E., managing director, Shell Co of Australia, Ltd, deputy chairman, Organizing Committee for the Olympic Games, Melbourne.

John Arthur Warder, director, Compania de Petroleo Shell de Colombia, South America.

G.C.V.O.

Brigadier-General Sir Harold Hartley, K.C.V.O., C.B.E., M.C.

O.B.E.

Frederick Edward Brettell Long, Welfare Officer, Staff Department, Shell-Mex and B.P. Ltd.

Captain James Frederick Rumbellow, Commodore Master, s.t.s. *Vibex*, Shell Tankers Ltd.

B.E.M.

Frederick Bassett Lovett, shipping foreman, Mobil Oil Co Ltd (Wandsworth Works).

James Henry Matthews, labour officer, Monsanto Chemicals Ltd, Newport.

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THE MINISTRY OF POWER

In reconstructing the British Government, the new Prime Minister, Harold Macmillan, has created a new Ministry of Power, to supersede the Ministry of Fuel and Power and to assume its existing functions on coal, gas, electricity, and petroleum. The Ministry will also be responsible for extending the use of atomic energy as an industrial power source. He will also take over from the President of The Board of Trade his responsibilities for iron and steel.

The new Minister of Power is Sir Percy Mills and he will receive a peerage, sit in the House of Lords, and be a member of the Cabinet. The announcement from Downing Street, in reference to the new Minister, said: "The inclusion in the Cabinet of this Minister, and the Minister of Transport, reflects the importance attached to the expansion and development of the basic materials and services which are vital to the efficiency of British industry".

The "Shell" Hydrodesulphurization Process

By G. R. STOREY

The following paper was read to a meeting of the Stanlow Branch on 14 December 1956. Mr Storey is on the staff of the "Shell" Refining and Marketing Co Ltd.

The problems arising from the presence of sulphur in crude oil have been present since the large-scale refining of crude oil began. These problems have been particularly troublesome to the refiners of Kuwait crude and will become more of a problem, since the sulphur content of Kuwait crude is tending to increase as the fields are further developed. The position is further aggravated by the more rigorous specifications now laid down for petroleum products. The sulphur content of crude oils may vary from 0·05 to 5 per cent depending on their source; the present sulphur content of Kuwait crude is about 2·5 per cent. The molecules which contain the sulphur in crude oil are complex, and they break down to simpler molecules in cracking and reforming operations, so that after a comprehensive series of refining processes the sulphur distribution in the products may be approximately as follows:—

Gas contains	18%	of the sulphur in the crude
Gasoline contains ...	7%	,, ,,
Distillate Fuel contains ...	18%	,, ,,
Residual Fuel contains ...	57%	,, ,,

The sulphur distribution for a typical catalytic cracking process is approximately:—

Gas contains	33%	of the sulphur in the feedstock
Gasoline contains ...	5%	,, ,,
Distillate Fuel contains ...	26%	,, ,,
Heavy Gas Oil contains ...	30%	,, ,,

It can be seen from these figures that a large part of the sulphur still remains in the heavier products.

In general, the sulphur compounds present in the refined products can be divided into three groups, as follows:—

(1) Compounds acidic in character, *e.g.* the mercaptans and hydrogen sulphide.
(2) Neutral and thermally stable compounds, *e.g.* the mono- and di-sulphides.
(3) Thermally stable cyclic compounds of the thiophene type.

These compounds are without exception objectionable from one or more points of view; odour, corrosivity, depression of knock rating and lead susceptibility, and stability or burning characteristics; so that there are naturally many processes at present in use to modify or remove them. The most direct remedy would be simply to remove the sulphur, but this is often neither easy nor economic. Many processes merely change the character of the sulphur compounds in the oil being treated in order to remove some of their more obvious bad properties. One instance of this is the well-known Doctor process, which removes the sour smell associated with the presence of mercaptans in gasoline. In this case, the gasoline is treated with a solution of litharge in caustic soda (Doctor Solution) and a solution of elementary sulphur in gasoline. By a series of complex reactions, the mercaptans are converted to the stable and odourless disulphides.

Sulphur present as hydrogen sulphide may be removed by washing the gas or liquid product with caustic soda solution; the spent caustic soda solution is then not regenerable. When the quantity of hydrogen sulphide is large, a regenerative process, such as the Girbotol, is used. This makes use of the reaction between the ethanolamines and hydrogen sulphide, which is reversed by boiling the amine solution.

For removal of low molecular weight mercaptans, caustic soda solution may be used regeneratively; for higher molecular weight mercaptans, such as those boiling in the gasoline range, the effectiveness of caustic soda can be raised to a useful level by the addition of other materials to the solution, *e.g.* methanol, alkyl phenols, or *iso*butyric acid. For products much heavier than gasoline however, these extraction methods are ineffective, partly because of unfavourable extraction characteristics of the mercaptans and partly because in the heavier petroleum fractions most of the sulphur is generally present as compounds other than mercaptans.

In an attempt to find an efficient economic desulphurization process for the heavier fractions, there have appeared a group of processes over the last few years which may be given the general title of catalytic hydrodesulphurization processes.

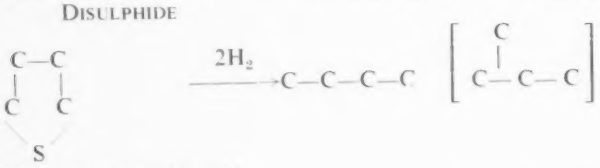
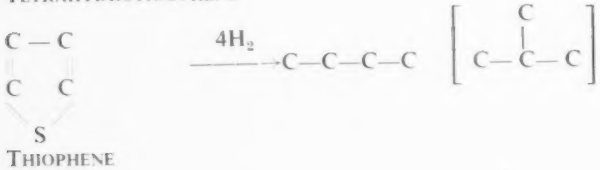
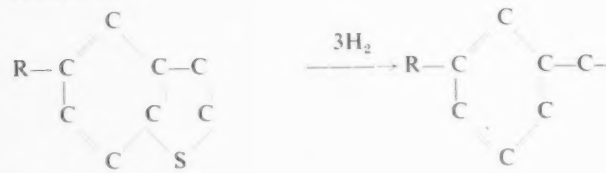
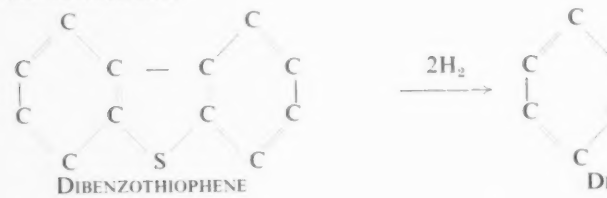
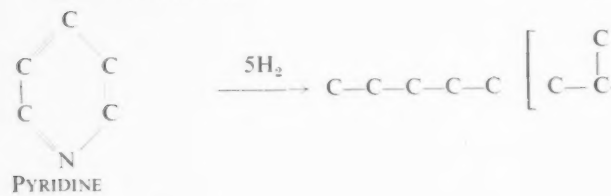
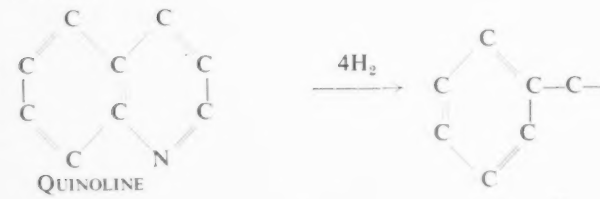
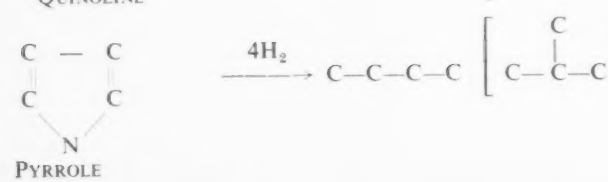
These processes involve the removal of sulphur from petroleum by the hydrogenation of the sulphur to hydrogen sulphide and the subsequent removal of this hydrogen sulphide by a variety of methods, the hydrogenation reaction being promoted catalytically. A general and simplified flow scheme which is valid for most of these processes is shown in Fig 1. The charge oil, which may be whole crude oil, reduced crude oil, or any of the distillate fuels, is first mixed with a hydrogen-rich gas, preheated, and passed through the reactor which contains the catalyst, generally in a fixed bed or beds. The reactor product is passed to a separator where the gases are flashed off and recycled, fresh hydrogen replacing the hydrogen used in the reaction.

The fact that this is possible has been known for some time, but the original high cost of hydrogen made the process uneconomic for large-scale refinery use. However, the increasing use of catalytic reforming techniques, such as the U.O.P. Platforming process, whose main reaction is the dehydrogenation of *cyclo*paraffins to aromatics, made available large amounts of low-cost hydrogen, and interest in catalytic hydrodesulphurization processes revived.

The sulphur level of Kuwait crude in the post-war period has been unfavourable for the required low sulphur contents

TABLE 1

TYPICAL REACTIONS OF SULPHUR COMPOUNDS WITH HYDROGEN

		Hydrogen required CF mol
(1)	$C{-}C{-}C{-}C{-}SH \xrightarrow{H_2} C{-}C{-}C{-}C + H_2S$ MERCAPTAN	379
(2)	$C{-}C{-}S{-}C{-}C \xrightarrow{2H_2} 2\,C{-}C + H_2S$ SULPHIDE	758
(3)	$C{-}C{-}S{-}S{-}C{-}C \xrightarrow{3H_2} 2\,C{-}C + 2H_2S$ DISULPHIDE	1137
(4)	 TETRAHYDROTHIOPHENE	758
(5)	 THIOPHENE	1516
(6)	 ALKYL BENZOTHIOPHENE	1137
(7)	 DIBENZOTHIOPHENE — DIPHENYL	758
(8)	 PYRIDINE	1895
(9)	 QUINOLINE	1516
(10)	 PYRROLE	1516

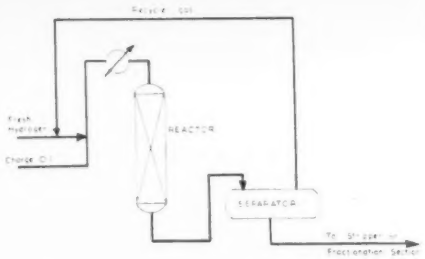


Fig 1.

of diesel engine and domestic fuels, and the Amsterdam laboratories of the Shell Group therefore began investigations into suitable processes for the desulphurization of components for these fuels. Catalytic cracking of flashed distillate from Kuwait crude produces a gasoline with acceptable sulphur content, but that of the cycle oils remains high, and the investigations considered mainly these products and the straight-run middle distillates. The methods considered included various solvent extraction processes, *e.g.* furfural and hydrofluoric acid, but the main drawbacks to these methods are that the extracts, being of high sulphur content, are of low value, and that the complete sulphur-containing molecule is removed by the solvent, resulting in low liquid yields. The yield position is further worsened by rather low selectivity for sulphur compounds of the solvents, and, lastly, since the material extracted is largely aromatic, the raffinate has low specific gravity and hence low calorific value per gallon. For these reasons, the decision was made to develop a process utilizing catalytic hydrodesulphurization. The objective was a low cost catalytic hydrodesulphurization process capable of deep desulphurization of straight-run and cracked middle distillates, with the desulphurization maintained for long on-stream periods without catalyst regeneration. The process should also be capable of handling heavier distillates if possible to produce some flexibility in refining operations.

Before dealing with the development of the "Shell" process, it is necessary to consider exactly what hydrodesulphurization is and what reactions are carried out in the process. Hydrodesulphurization, as defined here, is a catalytic hydrogenation process which has as its sole aim the removal of sulphur by the reaction of sulphur compounds with hydrogen to form hydrogen sulphide and one or two hydrocarbon molecules. Some typical reactions are shown in Table 1.

In straight-run gas oils and catalytically cracked cycle oils, the predominant sulphur compounds are alkyl benzothiophenes, as illustrated in reaction 6, while if the final boiling point of the cycle oils extends above 650° F the dibenzothiophenes are present. Reaction with the latter (number 7) is more difficult, and a reduction in desulphurization is generally found in stocks containing these compounds; furthermore, some saturation of the diphenyl also takes place. Some of the reactions with nitrogen compounds are illustrated by reactions 8, 9, and 10. Other reactions which also tend to occur are the saturation of olefinic materials to paraffins, the saturation of aromatics to naphthenes (this reaction is to be avoided if possible), and a certain amount of hydrocracking.

As mentioned previously, processes utilizing these general principles have been known for some time, the main deterrent to their development being cost. The problem of the high operating cost having been partially solved by the increasing availability of cheap hydrogen, a study was made of the remaining capital and operating costs for such a plant, and it was found that a reduction in the rate of recycle gas flow would appreciably reduce the cost of the plant. Any major reduction in the amount of recycled hydrogen, however, results in conditions where most of the feed remains in the liquid phase, as opposed to the conventional processes where reactions are largely in the vapour phase. Experiments were therefore carried out with heavy Kuwait straight-run gas oil using co-current flow of oil and hydrogen at varying space velocities and at varying gas rates. The results are shown in Fig 2.

The term "liquid hourly space velocity" (LHSV) is defined as the volume of oil at 60° F per volume of catalyst (expressed in the same units) per hour. Percentage desulphurization has been graphed against recycle gas rate. The decrease in percentage desulphurization for gas rates greater than that at the break point is thought to be due to the decrease in contact time and the decrease in the partial pressure of the oil, while the decrease shown below the break point is presumably due to lower mass transfer rates caused by the resistance of the oil film on the catalyst surface. At very low recycle rates, the low desulphurization is due to the low hydrogen partial pressure and the increased hydrogen sulphide partial pressure at the reactor exit. Reduction in desulphurization by operating with recycle gas rates of 250-1250 SCF/brl, as compared to that operating at the optimum about 5000 SCF/brl, is very small. Economic evaluations show that for a given sulphur content of product the cost of the small increase in reactor volume necessary to carry out the reaction in the liquid phase is very much offset by the saving in power, cost of compressors, and in heat transfer area; so much so that the capital investment for the trickle-phase process is 15-20 per cent less than that of the vapour-phase process, with a similar reduction in operating costs.

The catalyst requirements for a process of this kind were considered to be reasonable cost, high desulphurization, long life, easy regeneration, and a high degree of selectivity, as well as good mechanical strength. The catalyst has to be selective in order to reduce hydrogen consumption by eliminating undesirable side reactions, such as the hydrogenation of aromatics. There are various catalysts which

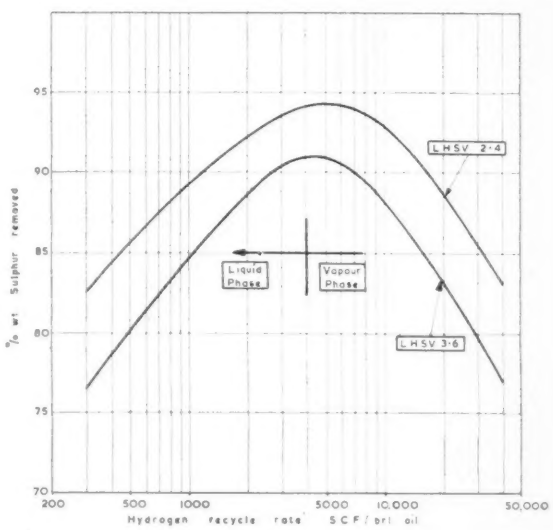


Fig 2.

possess these properties, such as molybdenum, magnesium and zinc oxides, or cobalt and molybdenum oxides, on bauxite or alumina. The latter type was found preferable for this application. The catalyst may be temporarily poisoned by carbon monoxide or water, but loss in activity is mainly due to the slow building up of carbonaceous deposits formed by polymerization of unsaturates and aromatics. Pilot plant tests indicated, however, that a catalyst life of approximately 12 months could be expected and that the catalyst could be successfully regenerated.

In the original pilot plant work on the process, hydrogen sulphide was always removed from the recycle gas, but it was found that at low gas rates the reduction in sulphur removal caused by leaving the hydrogen sulphide in the recycle gas was very small, and no permanent loss of catalyst activity was detected in runs of long duration. The hydrogen sulphide produced remains in the liquid reactor product and is removed at a later stage by stripping.

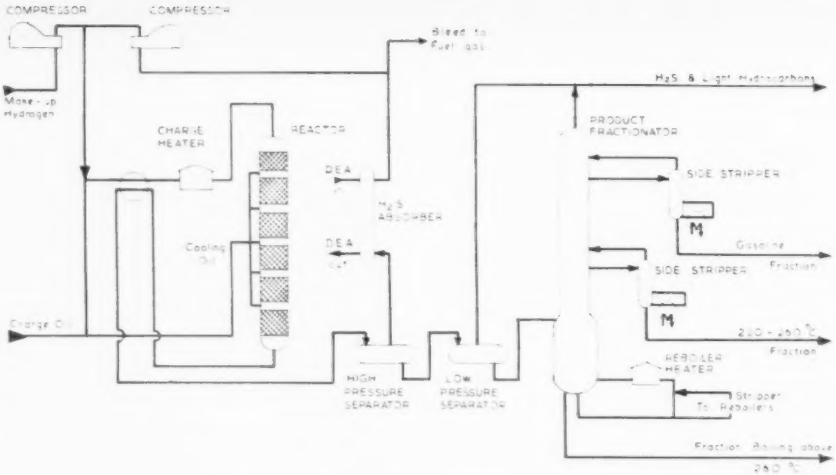


Fig 3. Simplified flow scheme—Stanlow hydrodesulphurizer.

Investigations were also made to find the optimum temperatures and pressures for reaction. It was found that below 650° F little desulphurization occurs; above this temperature there is increasing sulphur removal up to 750° F, where cracking begins to occur, with resultant coke lay-down, shorter catalyst life, and a reduction in liquid yield. The effect of varying pressure was studied in the range from 300-750 psi; in this range an increase in pressure has a beneficial effect on both desulphurization and catalyst life; these improvements, however, fall off gradually when approaching 750 psi, and operating at pressures above 750 psi cannot be economically justified for middle distillates. Therefore, the preferred conditions for 80-90 per cent desulphurization are at temperatures of 690 -720° F and pressures of 600-750 psi. In pilot plant runs under these conditions, and with recycle gas rates of 300-1250 SCF/brl, no significant decrease in catalyst activity could be found after 20,000 volumes of oil had passed over one volume of catalyst, using a straight-run feedstock. Using a cracked feedstock, no loss in activity was observed after 4000 volumes of oil had passed over one volume of catalyst. The amount of coke deposited was very small, less than 0·0005 per cent of the oil charged. An additional effect was observed to be a reduction of the Conradson carbon residue of the oil.

Because of the desirability of using impure hydrogen from catalytic reforming for this process, some attention was also paid to the effect of diluents in the make-up hydrogen. These diluents will concentrate in the recycle gas, and runs were carried out using recycle gas containing 15 per cent volume of methane; there was only a very small decrease in the degree of desulphurization. The percentage of diluents which can be tolerated is a function of the amount of hydrogen consumed, and with a feedstock of 1-1·5 per cent sulphur the make-up hydrogen can contain 7-10 per cent volume of methane or other hydrocarbon gases.

For stocks of higher sulphur content, the build-up of methane or other diluents in the recycle gas can be suppressed either by washing the gas with oil or by bleeding a small proportion out of the system.

The hydrogen consumption in the hydrodesulphurization of straight-run middle distillates in the conditions already mentioned is on average about 50 SCF/lb sulphur removed, or 4 mols of hydrogen per mol of sulphur removed. A slightly higher figure is found for Middle East cracked distillates. The theoretical minimum is 3 mols hydrogen/mol sulphur removed, based on type of sulphur components present in the feedstock. This confirms the selectivity of the catalyst; the hydrogenation of aromatics is completely suppressed but the hydrogenation of olefins cannot be entirely avoided. For the majority of crudes, sufficient hydrogen is available from the catalytic reforming of the naphtha cut to hydrodesulphurize the light catalytically cracked gas oil. This is true even for the low naphthene, high-sulphur Middle East crudes

The liquid product yields for the process are extremely high; they can in fact be greater than 100 per cent by volume due to the decrease in specific gravity obtained by the breaking of the complex sulphur-containing molecules. There is no production of light ends apart from that obtained by the breakdown of these molecules. These light ends may be obtained as a gasoline fraction of a very high octane number when processing light catalytically-cracked cycle oil. If desired, an engine fuel type of kerosine may be recovered.

In the design of commercial plants, provision must be made for dissipation of the heat of reaction when desulphurizing catalytically-cracked stocks of high sulphur content; in such a case, there is a temperature increase of 50°-60° F in the reactor per % of S removed, and as operation must be between the fairly narrow limits of 670°-720° F, temperature control is essential. This has been accomplished by dividing the catalyst charge in the reactor into a number of beds of varying heights, the heights of the beds increasing from the inlet towards the outlet. During operation, cold charge oil is injected between these beds on to a mixing tray. Intimate mixing of the cold oil to obtain temperature equalization is necessary and special trays were designed for this purpose.

The commercial applications of the "trickle" process are quite diverse. High-sulphur content straight-run gas oils and catalytically-cracked cycle oils can be desulphurized into high-grade diesel fuel components and burning oils. High-sulphur low-value heavy naphthas can be upgraded by desulphurization to low-sulphur mineral spirits; these light products are more easily desulphurized than gas oils. Hydrodesulphurization also improves flashed distillates as catalytic cracking feedstock; when cracking the hydrogenated stock a lower coke production and a higher gasoline yield result.

After several years investigation along the lines already described, the first commercial "trickle phase" hydrodesulphurization unit was erected at the Stanlow refinery of the "Shell" Refining and Marketing Company and was brought on stream at the beginning of 1955. This unit was designed for the production of a desulphurized diesel oil component from light catalytically-cracked cycle oil and straight-run gas oils. A simplified flow diagram of the unit is shown in Fig 3. Fresh hydrogen and hydrogen-rich recycle gas are compressed by separate compressors to the operating pressures, and the compressed gases are then combined with a major part of the charge oil. The combined stream is first preheated against the reactor effluent and then heated to reactor inlet temperature by the reactor charge heater. The remainder of the charge oil is fed cold to the reactor to dissipate the heat of reaction. The reactor product, consisting of hydrogen, light hydrocarbons, desulphurized gas oil, and hydrogen sulphide, is heat exchanged as already mentioned, cooled, and flows into the high-pressure separator where the hydrogen-rich recycle gas is separated. The recycle gas is scrubbed with diethanolamine solution to remove H_2S, and is then compressed by the recycle gas compressor with a bleed to fuel gas. The high-pressure separator liquid passes to the low-pressure separator, and the liquid from this vessel flows to the product fractionation section. This consists of a main fractionator and two side strippers, where the desulphurized liquid product is split into three fractions, and hydrogen sulphide with small amounts of hydrocarbon gas are removed overhead. The overhead gas from the fractionator and the low-pressure separator gas combine and go to the gas separating plant. The reboiler heat for the strippers is provided by the main fractionator bottom stream, and the main column has a reboiler furnace. The products of the unit are then:—

(1) Hydrogen sulphide
(2) A highly aromatic heavy gasoline
(3) A 400°-500° F fraction
(4) A bottom product boiling at over 500° F.

The product distribution was as expected, with nearly 70 per cent boiling at over 500° F.

The unit started up smoothly and has operated successfully on a variety of feedstocks, with little deterioration in catalyst performance. In Table 2 the properties of the products obtained from light catalytically-cracked cycle oil are given; the sulphur contents show desulphurization to the extent of about 88 per cent. The colour of the feedstock is also slightly improved, and the high octane number of the gasoline fraction is demonstrated, the ratings being quoted as ml TEL necessary to bring the reference fuel (*iso*-octane) to the same rating as the test sample. Table 3 shows results obtained when processing a 70/30 blend of light catalytically-cracked cycle oil and heavy straight-run gas oil respectively. The desulphurization is again of the order of 88 per cent; the octane ratings of the gasoline, while still high, are not so high as in Table 2, due to the lower aromatic content. In both tables the total volume yield is greater that 100 per cent.

Briefly, the "Shell" hydrodesulphurization process is a versatile one which is capable of many applications. The adoption of the "trickle phase" technique means that higher boiling distillates can be desulphurized without the high recycle gas rates which would be necessary for a vapour-phase process. Desulphurization, of course, becomes more difficult with increasing boiling range and molecular weight, and space velocity has to be reduced, but relatively deep desulphurization can still be obtained at attractive space velocities even at very low recycle rates.

TABLE 2

Feedstock:
Middle East light catalytically-cracked cycle oil.

Properties	*Feed*	*Products*		
		400° F	400°-500° F	500° F +
ASTM Distillation				
IBP °F	400	311	403	484
10% vol rec'd at °F ...	480	318	419	509
50% vol rec'd at °F ...	534	328	446	552
90% vol rec'd at °F ...	612	344	467	617
F.B.P. °F	648	378	511	653
Sulphur content % wt ...	2·48	0·01	0·06	0·35
Diesel Index	21			31
Visc Red. 1 at 100° F, sec			30	35
Colour (Union)	1½+			1½−
Knock Rating				
F1 clear		+0·16*		
F1 + 1·5 ml TEL I.G.		+0·55*		
Aromatics % vol... ...	60	82	71	57
Yield % vol	100	5	25	72

*ml TEL I.G. *iso*-octane

TABLE 3

Feedstock:
70 30 blend by weight of light catalytically-cracked cycle oil and straight-run heavy gas oil of Middle East origin.

Properties	*Feed*	*Products*		
		400° F	400°-500° F	500° F +
ASTM Distillation				
I.B.P. °F	426	291	392	500
10% vol rec'd at °F ...	—	327	432	534
50% vol rec'd at °F ...	—	340	446	581
90% vol rec'd at °F ...	642	356	478	647
F.B.P. °F	682	403	509	674
Sulphur content % wt ...	2·28	0·01	0·04	0·31
Diesel Index	32			43
Visc Red 1 at 100° F, sec			30	
Colour (Union)				1+
Knock Rating				
F1 clear		100		
F1 + 1·5 ml TEL I.G.		+0·3*		
Aromatics % vol... ...	—	72	66	—
Yield % vol	100	5	21·5	76

*ml TEL I.G. *iso*-octane

Acknowledgment

The author thanks the directors of the "Shell" Refining and Marketing Co Ltd for permission to publish this paper.

Around the Branches

BAHRAIN, FAWLEY, KUWAIT, LONDON, NORTHERN, SCOTTISH, SOUTH-EASTERN, SOUTH WALES, STANLOW, TRINIDAD

Among those present at the London Branch Film Show in December were (left) *J. Bell, just home from Barbados, and seen talking to Norman Hitchcock* (Committee Member) *and E. Thornton seen* (with pipe) *with W. H. Davies* (Committee Member), *J. C. Jewell* (Vice-Chairman), *and R. F. Leach* (Chairman).

London Branch Film Evening

As was anticipated, the success of the London Branch annual Film Evening was assured as soon as it was announced. Within a very short time so many applications for tickets had been received that arrangements had to be made for the show to be repeated. So, on 14 and 17 December last, the Mezzanine Cinema at Shell-Mex House was fully occupied by the Branch members and their ladies.

Three films were shown. The first—*The Ruthless One*—depicted the life cycle of what is probably man's greatest enemy, the locust. It also illustrated some of the counter measures taken to defeat the pest and stressed the need for international co-operation if this was to be effective.

Film number two showed a more peaceful scene and pictured some of the beauty spots along the 5000 miles of Britain's coastline. *Our Native Shore* also emphasized the crafts and callings associated with the coast.

The third film took the audience to far distant parts of the world and showed how The Trans-Antarctic Expedition had obtained a *Foothold on Antarctica*. It covered the thrilling first voyage of the *Theron* and ended as the vessel left for London, leaving behind the party of eight who were to build camp ready for the main party to return.

At the end of the show, the chairman of the Branch, R. F. Leach, expressed thanks to The Shell Petroleum Company, to the Esso Petroleum Company, and to The British Petroleum Company for their kindness in making the three films available.

He then invited his audience to take refreshments

At the London Branch Film Show.

More photos of the London Branch Film Show.

with Shell-Mex and BP Ltd in the adjoining room. This latter function was much appreciated by everyone, the accompanying photos leaving no doubt as to this.

Scottish Branch

A joint meeting of the Branch with the Stirlingshire and District Sections of the Royal Institute of Chemistry and the Society of Chemical Industry was held on 18 December. Dr G. H. Smith, M.C. (Hon. Treasurer) introduced Dr McLean, chief research chemist to British Hydrocarbon Chemicals Ltd, who presented a paper on "Some Aspects of Petroleum Chemicals".

Dr McLean said that the development of the art of cracking, particularly thermal cracking, by the petroleum industry and of distillation, mainly by the petroleum industry, had made possible the advent of the petroleum chemicals industry. This development, he said, started in the U.S.A. during and immediately after the first world war. In 1920, no pure chemicals were made from petroleum; in 1955, the U.S.A. produced 13 million tons in ever-widening variety; one forecast was made that by 1960 this production would be 27 million tons. In Europe, the petroleum chemicals industry was developing along similar but not quite parallel lines.

Continuing, the author said that the lower olefins in refinery off-gas from thermal cracking were the petroleum chemical industry's original raw materials, but as catalytic cracking displaced the purely thermal operation in petroleum processing, the new industry developed its own cracking processes and concomitantly began to use new feedstocks such as natural gas, liquefied petroleum gases, and even naphthas and residual fuel oils. The cracked product was often a very complex mixture, from hydrogen and methane upwards, and was usually highly olefinic. Distillation based on proven fundamental principles enabled the separation of the lower olefins in states of purity such that they could be used for chemical syntheses; distillation in conjunction with other physical and chemical processes was continually extending the range of available pure feedstocks.

In regard to ethylene, Dr McLean said that this was one of the first primary petroleum chemicals to become an industrial commodity; in 1955, it was still the industry's major raw material. Most of this production was still converted to ethanol but in the next 5 to 10 years the requirement for polyethylenes of all kinds might outstrip this use. Other large uses were for ethylene oxide, ethylene glycol, styrene, and PVC.

He said that propylene was probably the first basic petroleum chemical to be used industrially, but had increased in stature more slowly than ethylene. It was now finding uses in a number of processes, the chemistry of which was novel. As examples of these, he cited the phenol/acetone process starting with *iso*propylbenzene and synthetic glycerine processes.

The author emphasized that by far the largest tonnage C_4 petroleum chemical was 1,3-butadiene. This substance still found its biggest use as a copolymer with styrene in GR-S rubbers but it also had growing uses in other chemical conversions.

In the separation of pure aromatics such as benzene, toluene, and xylenes from petroleum, Dr McLean recalled that Western Europe and particularly the U.K. had for economic reasons diverged from the U.S. pattern of petroleum chemical development. He felt, however, that the growing demand for benzene and the xylenes for chemical syntheses may change this situation in the near future.

Finally, the author said that the availability of natural gas and large quantities of lower paraffins from catalytic cracking caused the chemical conversion of these materials to grow phenomenally in the U.S.A. The use of the methane/steam reaction and partial oxidation with oxygen gave synthesis gas for methanol and formaldehyde, whilst reforming of the gas provided hydrogen for ammonia synthesis and carbon dioxide which with the ammonia yielded urea. Another growing use of the lower paraffins was in the manufacture of acetylene by several processes.

South-Eastern Branch

A Branch meeting was held on 4 December at the King's Head Hotel, Rochester, when A. C. Hartley, a vice-president of the Institute, gave a talk on "Pluto" to about 50 members and visitors. Mr Hartley's talk was admirably illustrated with lantern slides and films, and covered the whole history of the undersea pipelines to France—from the first suggestion in 1942 to their salvage in 1948.

The Pluto network, which extended from Stanlow and Avonmouth to Frankfurt-am-Main and Emmerich, involved 17 submarine lines, totalling over 600 miles, across the Channel. The pipes were either of lead,

wound with steel tape and wire, or of mild steel, and the internal diameters were two or three inches. The steel pipes suffered severe corrosion and had lives of only two or three months, but the lead pipes were unaffected by four years immersion in the sea. That the system was of considerable strategic importance is shown by the fact that during its year's operation, Pluto carried 172 million gallons of motor spirit to the Allied armies, at rates up to one and a half million gallons per day.

After his most interesting talk, Mr Hartley answered a large number of questions. Finally the film *Facts and Fancies* was shown.

South Wales Branch

A joint meeting with the South Wales Branch of the Institute of Fuel was held on 2 November when G. F. J. Murray, M.I.C.E., A.M.Inst. H. & V. Eng., A.F.Inst.Pet., presented a paper on "Petroleum Fuels for Domestic Heating and Lighting". The chair was taken by J. T. Davies, chairman of the South Wales Branch, Institute of Fuel.

Mr Murray opened his talk with an account of propane and butane and emphasized their higher calorific values and specific gravities with town gas.

He pointed out that, in the U.K., butane was the most commonly used gas in a wide variety of domestic appliances. In general, butane served the domestic field and propane the industrial field.

Mr Murray then referred to the catalytic stove, which, in countries where taxation permits, uses a lead-free straight-run distillate of 70 —100 C boiling range. This stove, he said, was suitable only for space heating.

In regard to kerosine-burning appliances, Mr Murray emphasized the importance of the influence of various aspects of kerosine quality, *e.g.* the higher the smoke point the higher the possible heat output of a heater or cooker. He also mentioned the effect of char value or burning quality and the odour of the products of combustion.

Kerosine heaters were classified as follows:—

(a) Long-drum burners of the white flame or blue flame type.

(b) Short-drum burners of the wick-fed or kindler type.

(c) Pressure burners.

Space heaters included the radiator type, convector heaters, and those giving a proportion of true radiant heat.

He also said that the range of cookers covered every type from the simple Primus to the multi-burner with oven. Moreover, kerosine could be used for such widely diverse appliances as refrigerators and smoothing irons. It also had an important application in lighting appliances, either wick-fed or pressure-operated.

In regard to oil-fired boilers, Mr Murray said that the types of burner could be classified as follows:—

(a) The pot type vaporizing burner.

(b) The emulsion type.

(c) The fully automatic pressure-jet burner.

Mr Murray illustrated his talk with graphs and tables, and gave data of work at Sunbury Research Station on variations of smoke density, thermal efficiencies, oil consumption, etc., on such fuels as kerosine, gas oil, catalytically cracked gas oil, marine diesel, No. 1 fuel oil, and No. 2 fuel oil.

This interesting lecture was followed by a lively discussion. E. Thornton proposed a vote of thanks, which was well accorded.

★ ★ ★

COLONEL S. J. M. AULD, FELLOW OF QUEEN MARY COLLEGE

Our congratulations to Colonel **S. J. M. Auld,** O.B.E., M.C., D.Sc., Ph.D., a past-president of the Institute, who was admitted a Fellow of Queen Mary College at a College Assembly held on 11 December last. This was on the occasion of the 22nd anniversary of the presentation of the Royal Charter to the College.

In presenting Colonel Auld for admission to the College, the Principal, Sir Thomas Creed, K.B.E., M.C., Q.C., M.A., referred to Colonel Auld's early association with the College. Elected to his scholarship in 1896, he later went to Germany to take his first degree and returned in 1907 to take his second degree. In that year the College was recognized as a School of the University of London. Therefore, he said, Colonel Auld must have been one of the first research students of the College to take a degree of Doctor of Science.

After outlining Colonel Auld's achievements, Sir Thomas concluded that confirmation of his many claims to distinction was found in the fact that he had been "exceptionally honoured by being twice elected as President of the Institute of Petroleum, a body which co-ordinates research and development in this most vital industry."

HARRY HYAMS, HONORARY MEMBER OF ASTM D-2

Harry Hyams, a Member of Council of the IP and its most recent Eastlake Medallist, has been unanimously elected to the Honorary Membership of ASTM Committee D-2 on Petroleum Products and Lubricants. The citation made when his name was submitted for election read:

"He has championed closer ties between the Institute of Petroleum and Committee D-2 for many years and was instrumental in making the joint publication of the ASTM-IP Petroleum Measurement Tables possible."

Mr Hyams is the fifth Britisher to receive this distinction, the others being: Lt.-Col. S. J. M. Auld, Dr A. E. Dunstan, Professor F. H. Garner, and J. A. Oriel.

MIDDLE EAST PRODUCTION

	November	*Jan.-Nov.*
	Tons	
Iraq Petroleum Co Ltd	204,419	20,962,734
Basrah Petroleum Co Ltd	515,774	7,679,011
Mosul Petroleum Co Ltd	8,675	1,077,927
Qatar Petroleum Co Ltd	342,152	5,316,806
Kuwait Oil Co Ltd	2,275,219	50,676,630
Iraanse Aardolie Exploratie en Productie Mij	2,094,000	23,803,000

The refinery throughput at Abadan of the Iraanse Aardolie Raffinage Mij for November was 1,183,000 tons, the total for January to November being 10,012,000 tons.

The British Andean Expedition

The object of the British Andean Expedition was to explore the little-known regions of the Andes of Southern Peru, and the Expedition was, in fact, one of the very few from the U.K. which have ever worked in the Andes.

Edward Whymper, the conqueror of the Matterhorn, climbed a number of volcanoes in Ecuador during the nineteenth century, and Sir Martin Conway was in Bolivia before the first world war. The Andes have hitherto been neglected by British mountaineers.

A lead mine in the Andes at 17,000 *feet.*

The Cordilleras Vilcanota and Caravaya, about which little is known, offered the most promising areas. They lie south-east of Cusco, the old capital of the former Inca Empire, and border the Amazon basin.

The Expedition, on which John Jewell (IP London Branch vice-chairman) was accompanied by Pat O'Donoghue, a dental surgeon, and Ralph Whiting, a geography schoolmaster, left Liverpool on 5 April 1956 and three weeks later arrived in Peru, where they were joined by Colin Darbyshire, an accountant.

After six busy days in Lima, the capital of Peru, completing arrangements for the three months to be spent in the mountains, the Expedition left on its 900-mile journey. Base Camp was eventually established on 22 May, high in the Cordillera Vilcanota at an altitude of 16,600 feet, just south of the Chimboya pass.

The base camp at 16,600 *feet in the Cordillera Vilcanota.*

Seated (left to right, *Colin Darbyshire, John Jewell, Pat O'Donoghue, and Ralph Whiting, with* (standing) *Agosto and Eustachi.*

The Expedition was extremely active in the Chimboya area, undertaking a varied programme of climbing, exploration, and scientific work. First ascents were made of a number of peaks between 18,000 and 19,000 feet. A survey was made of the area and the Expedition believes it is the first to attempt any work on the Quenamari ice plateau. This extensive area of inland ice is the remnant of an ice sheet which once covered this part of the Andes. It is thought to be the only such ice cap existing to-day in the tropics and it is of considerable geological and glaciological interest.

Little meteorological data are available from this part of the world and detailed observations were made at Base Camp. These are the subject of a specialized report.

The Expedition had to contend with the special conditions, imposed by the nearness of the Equator. Daylight

The old Inca city of Macchu Pichu, which lay buried under jungle until discovered by Henry Bingham in 1912.

was restricted to 12 hours and the temperature fell rapidly during the long night to −4° F.

Specimens were collected for the Natural History Museum, and a thousand photographs and colour transparencies were taken of all phases of the Expedition, including some interesting scenes of the former Inca civilization.

A colour film was also made. A selection of the colour transparencies was shown by John Jewell to an enthusiastic audience in Shell-Mex House Cinema on 2 November.

The Expedition, which received the approval of the Royal Geographical Society, was financed essentially by the members themselves but they wish to acknowledge their indebtedness to those companies and individuals who gave them invaluable assistance with materials, supplies, and information.

Personal Notes

R. T. Campbell.

R. T. Campbell, who was until recently manager of Mobil Oil Company's Northern Industrial Division in Manchester, has been appointed general manager of Industrial Divisions at the Company's head office in London. Mr Campbell has been succeeded in the Northern Industrial Division by **D. B. Hunt,** who was previously a district manager in Mobil's Divisional Office in Manchester.

H. D. Williams, A.F.Inst.Pet., has joined the Stanhope-Seta Co Ltd. and is in charge of the Research and Development Division. Previously, Mr Williams was with the Ministry of Supply A.I.D. Laboratories at Harefield, where he was responsible for the control testing of a wide range of aviation lubricants and other products.

C. E. Evans, O.B.E., B.Sc., F.R.I.C., F.Inst.Pet., previously general manager of the British Hydrocarbon Chemicals works at Grangemouth, has been appointed general manager of the Company; and **D. Blair Watt,** M.Inst.Pet., has been appointed works general manager at Grangemouth.

F. P. Barribal, M.B.E., A.M.I.M.I., M.Inst.Pet., automotive general sales manager of Mobil Oil Co Ltd, has been appointed a director of the company. Mr Barribal joined Mobil in 1926 and three years later became a salesman in the London area. From 1934 to 1940 he was staff manager and after the war he was appointed manager of the London automotive sales division. In 1951, Mr Barribal took charge of the newly formed Automotive Fuels Department, before becoming general sales manager.

J. A. Paul.

F. P. Barribal.

J. A. Paul, A.M.Inst.Pet., manager of Mobil Oil Company's Supply Department since 1953, has also been appointed a director of the company. In addition, Mr Paul has assumed responsibility for the Wholesale Lubricating Oils and Foreign Shipping Departments.

J. Ornstein, deputy chairman and managing director of BP's German associated company, BP Benzin und Petroleum G.m.b.H., has been appointed an honorary Commander of the Order of the British Empire for services to the British community in Germany.

Mr Ornstein, who is French, has had 44 years' service with the oil industry, most of it with the BP Group in France and Germany. After the last war, he became BP's representative in Germany and managing director of the German company.

H.E. Sir Frederick Hoyar Millar, G.C.M.G., C.V.O., (left) presenting J. Ornstein with the award on 6 December.

A BP photograph

J. L. N. Pollock, M.Inst.Pet., a director of the Esso Petroleum Co Ltd, has retired from the Board, after completing 37 years' service with the Company. He has also relinquished his directorships of subsidiary companies of the Esso group.

Mr Pollock joined Esso in 1919 as a sales representative, and through successive promotions on the marketing side was appointed a director of the Company in 1938. For the past ten years he has been primarily engaged in the development of the employee and public relations activities of the Company.

J. L. N. Pollock.

Photographs by DOUGLAS GLASS

D. A. C. Dewdney.

D. A. C. Dewdney, B.Sc., F.Inst.Pet., manager of Esso's Co-ordination and Economics Department, has been appointed a director of the Company. Mr Dewdney obtained First Class Honours in Petroleum Technology at Birmingham University and was a Cadman Medallist there. He joined Esso in 1936 as a technical assistant and subsequently held a number of important positions in the Company's research and refining operations.

A. C. Durie, who recently returned from Australia after concluding a two-year appointment with the Shell Company of Australia Ltd as a director of the local

[*Concluded on page 52*]

Notes of the Month

Industrial Carbon and Graphite Conference

A conference on industrial carbon and graphite is being arranged by the Society of Chemical Industry, and will be held at the William Beveridge Hall, London University, from 24 to 26 September 1957.

The Hon. Sec. of the Conference is E. A. Smith, Acheson Colloids Ltd, 18 Pall Mall, London, S.W.1 (Telephone: Whitehall 2034/7).

Second Cuban Petroleum Congress

The Second Cuban Petroleum Congress will be held in Havana from 5 to 11 May 1957. The Congress will include an industry exhibit, which will be open to the public, and technical and scientific sessions, attendance at which will be limited to registrants.

Further details may be obtained from Second Cuban Petroleum Congress, Edificio Habana 800, Havana, Cuba.

Nuclear Energy Conference

In order to establish a permanent means of liaison on matters relating to nuclear energy and associated developments, the Nuclear Energy Trade Association's Conference (NETAC) has been formed. Membership, which in no way restricts the autonomy of the participants, is open to those trade associations concerned with nuclear energy equipment.

The address of NETAC is 32 Victoria Street, London, S.W.1.

Seventh Cuban Producer

Consolidated Cuban Petroleum Corpn has announced that its seventh well, Consolidated Cuban No. 3, started to produce, when drilling at 940 ft, on 5 December 1956, and during the first 72 hours produced a total of 1786 brl.

The flow ceased on 8 December, due, it is believed, to an obstruction which entered the casing suspended 33 feet above the bottom of the hole. Until cleaning-out operations are begun, it will not be possible to estimate the average rate of production.

U.S. View on West Europe's Oil Supplies

The oil industry may be able to provide from the Western Hemisphere enough oil so that, when added to what can be moved from the Middle East, up to 80 per cent of Western Europe's normal needs will be covered as long as the present situation continues.

This view was expressed by M. J. Rathbone, president of Standard Oil Company (New Jersey), when he addressed the Chamber of Commerce at Tulsa, Oklahoma on 11 December last.

Mr Rathbone recalled the flexibility and resourcefulness of the oil industry when faced with emergencies in the past, which enabled him to provide "hopeful assurance" to the oil consumers most directly affected by the closure of the Suez Canal and the cutting of one of the major pipelines.

He added that just as soon as deliveries of oil to Europe from accustomed sources began to decline, shipments from the Western Hemisphere stepped up. With the recent reactivation of the U.S. Middle East Emergency Committee the shipments are mounting still higher.

To alter the established pattern of oil movements, both inside the U.S. and to overseas consumers, would be a tremendous task. "To give an idea of the specific action required" he continued, "one Esso affiliate has reversed the flow of a pipeline previously carrying refined products inland from the Gulf Coast and is now using it to bring crude down to the coast. Other affiliates are studying the possibility of taking oil from points as far inland as Montana to the Mississippi River, thence to the Gulf Coast by barge".

In Mr Rathbone's view, the movement of the oil is a greater problem than the availability of the oil itself, involving as it does not only transportation from the producing fields to deep water, but also ocean transport to overseas consumers. "Tankers are the crux of the latter job" he said, "but . . .', it should now be possible, through the work of the U.S. Middle East Emergency Committee, to use available tankers in the most efficient manner".

New Oil Find in Nigeria

Oil and gas have been encountered during the first stages of testing an exploration well near Afan, 20 miles east of Port Harcourt, Nigeria. The full potentialities of the well will not be known until further sand layers higher up have been tested by Shell-BP. However, the preliminary results indicate that the discovery may be worth appraising by further drilling, and a location for a second well is now being prepared, about $\frac{1}{4}$ mile north of the first. The second well will be drilled on completion of testing in the first well, if results continue to be encouraging.

The Iraq Pipeline

The Iraq Petroleum Company informed the Syrian Government on 14 January that by pumping from T.1 Station in Iraq, pumping of Kirkuk oil to the Mediterranean terminals of Banias (Syria) and Tripoli (Lebanon) could be resumed at a rate of 11 million tons per annum within seven days of repair work being started. The Company has accordingly requested the confirmation of the Syrian Government that repair work may be put in hand immediately, so that pumping can be resumed.

From the preliminary reports of the sabotage of the pumping stations in Syria on the night of 2-3 November 1956, the Company deduced that it might be possible, by by-passing the damaged stations, to pump oil from the stations in Iraq at something between one third and one half the full capacity of the pipeline system. At that time conditions were not such as to permit examination of the line or the damaged pumping station.

On 23 December, senior members of the Company, led by Mr G. H. Herridge, Executive Director, flew to Damascus at the invitation of the Syrian Government to discuss the possibility of resuming operations in Syria. As a result it was arranged, with the co-operation of the Government, for a team of experts to examine the pipeline to investigate the possibility of the early resumption of pumping. Their report confirms that pumping could be resumed at the rate stated within a week of repairs being started. This quantity is equivalent to one third of the present gap between European requirements of petroleum and present supplies.

Largest Oil Tanker Ever to Dock in the U.K.

The largest oil tanker ever to dock in the U.K. berthed at Esso Refinery, Fawley, on 24 December. She is the *Sinclair Petrolore*, an American-owned oil/ore carrier of 56,089 deadweight tons, and the first ship to be diverted to Fawley under the special arrangements recently approved by the U.S. authorities for oil aid to Europe.

Her cargo of 52,600 tons of crude oil from Kuwait, via the Cape of Good Hope, was originally intended for an

Sinclair Petrolore.

American oil company in Philadelphia. The opportunity to acquire it for Esso Petroleum Company thus represents a substantial net saving in tanker tonnage.

The *Sinclair Petrolore* was built a year ago in Japan. She is 789 feet long and has a beam of 106 ft 5 inches. Due to her exceptional draught of approximately 40 ft (which is greater than that of the *Queen Mary*) she could only be berthed at the top of the tide, and the utmost speed in pumping out the first 10,000 tons of cargo was essential, since at low tide there is only 34 ft of water at the jetty. Three berths had to be kept clear to enable her to dock.

Oil Drilling Platform Wrecked

Shell's 1200-ton movable oil drilling platform, which (as reported in these columns—1954, **8**, 252) was set up in the Persian Gulf, was wrecked 50 miles off the coast of Qatar. A number of Qatari Arabs lost their lives. As far as is known there were no casualties among the European technical personnel.

The accident happened at about 11 p.m. on 30 December last, while the platform was being towed to Doha for modification. As a result of a sudden change in wind direction, a heavy swell developed and the two 2000-ton pontoons supporting the platform for towing broke loose. The electricity generating machinery on the structure was damaged and all the lights were extinguished. The platform legs were also damaged and the helicopter landing stage collapsed, though the helicopter escaped.

Soon after midnight it was decided to withdraw all personnel from the platform. One of the pontoons is reported to have subsequently sunk and further damage to the platform has been sustained.

A 12,000-ft well had just been completed at the site of the accident, without finding oil. This was the second well drilled by Shell in their offshore concession at Qatar where more than £7,500,000 has been spent in oil exploration in the past two years. The first well was spudded in during February 1955 and later abandoned at 6700 ft. A third well had been planned to start in the early months of this year. The platform was valued at £900,000.

Plan for Tanker Terminal in Wales

BP have released further details of the proposed crude oil tanker terminal at Popton Point on the south shore of Milford Haven, Pembrokeshire (announced in our November issue, p. 302).

The terminal's jetty would have two berths and vessels would discharge their cargoes by means of their own pumps direct into a transfer pipeline connecting with a tank farm 1½ miles away at the south-east corner of Angle Bay. Only one main pumping station, electrically operated, would be required to pump the crude oil along the pipeline to Llandarcy. Care would be taken to preserve the natural beauty of the district.

The channel into Milford Haven, giving a depth of 10 fathoms, passes close to the proposed site of the new jetty, but some dredging may be necessary, chiefly to provide a turning area for tankers.

Construction work on the project cannot start until Parliament approves the relevant Bill which will be introduced during the present session. If the Bill receives the Royal Assent by July, construction work would begin shortly afterwards. The project should be completed in about two years from the starting date.

X-Ray Diffraction Data

The X-ray diffraction data card file published by ASTM is now being offered to colleges and universities for classroom instruction at 80 per cent discount from the list prices. ASTM acts as business agent for the Joint Committee on Chemical Analysis by Power Diffraction Methods, which has compiled data for the identification of approximately 5000 crystalline materials by the Hanawalt Method.

The data have been collected from industry, literature, and laboratories and are available on plain 3×5-inch cards, 4×6-inch Keysort cards, and standard IBM cards. The Keysort cards have the Keysort coding around the border with holes punched but not notch coded. Instructions for coding are supplied with the Keysort cards.

Details and prices of the X-ray diffraction data card file are available on application to the X-ray Dept., American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

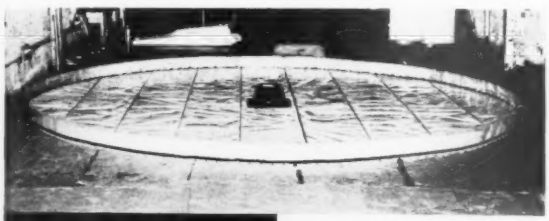
Prototype Jet Airliner.

(Above) *The prototype French jet airliner, the SE-210 Caravelle, being refuelled at Lisbon by the Companhia Portuguesa dos Petroleos BP, and* (right) *a tail view showing the position of the engines.*

New Type of Floating "Roof"

Designed by an employee of the Société Français des Pétroles, a new type of floating "blanket" to minimize evaporation losses from storage tanks is being fitted to some of the tanks at BP refineries in Europe.

Made of polyvinyl chloride sheeting, this "blanket" rests on the oil surface, being supported by a large number of small floats on its under-surface. A vertical skirting around the edge of the blanket forms an effective seal and is sufficiently elastic to pass over any rivets. Provision is made to prevent the blanket dropping below the inlet pipes. A considerable reduction in evaporation losses is claimed.



The blanket (above) *as it will float on top of the oil and* (left) *being inserted into the tank through one of the manholes*

The blanket is completely impervious and unaffected by petroleum or its products and also provides some protection against fire hazards. It is now being manufactured by a French firm.

Natural Gas at Cousland

The Scottish Gas Board has decided to carry out a prolonged test of the natural gas resources existing at Cousland, near Edinburgh, to establish whether the supplies of town gas to consumers could be augmented from this source on a commercial basis.

The closed-in pressure of the gas at well-head is about 600 psi and, after being reduced by means of a suitable governor, this pressure will be used during the test to convey the gas through a main, 4 miles in length, to the gasworks at Musselburgh. Here, it will be mixed with coal gas produced from the existing continuous-vertical-retort installation, and then distributed to consumers in the area.

Should the test lead to commercial production, it is possible that a saving of some 5000-10,000 tons of coal per annum will be effected.

Oil for Western Europe

Esso Standard Oil Company's marine terminal at Avondale, Louisiana, which has a storage capacity for 48,000 tons of crude oil, has been temporarily reopened to handle crude oil shipments to Europe.

In making this announcement, H. J. Voorhies, vice-president of Esso Standard Oil Co and general manager of the Baton Rouge refinery, stressed that this was a purely temporary measure undertaken to help solve the critical problems of oil supplies for Western Europe for the duration of the Middle East crisis. As soon as normal oil supply patterns had been re-established, the terminal would again be closed.

Endowment Prizes

The Royal Society of Arts, as trustee for the undermentioned endowments, offers the following prizes in 1957.

Howard Prize of £50 for Mechanical Motive Power. This prize will be awarded to the author of a treatise on some aspect of the subject of motive agents.

Fothergill prize of £20 for Fire Prevention or Fire Fighting. This prize is offered for a descriptive essay or model embodying a new idea for fire prevention or suppression.

Entries for the above prizes must be received by the Secretary of the Royal Society of Arts, 6-8 John Adam Street, Adelphi, London, W.C.2, not later than 31 July 1957, and must be clearly marked with the entrant's name and address and the prize for which they are submitted. Essays must be typewritten.

Gas Turbines for South America and Borneo

For the supply of additional power in the oilfields of Venezuela, Colombia, and Borneo, Shell have ordered nine gas turbine generating sets at a cost of nearly £1½ million. The turbines are designed to burn the natural gas which is available from the wells in large quantities. This type of plant uses little or no water.

Four of the sets are for use at La Concepcion, which supplies power for the Compania Shell de Venezuela's field in the Maracaibo-Mara District.

Of the remaining five sets, all of which were ordered in 1956, three are being manufactured by British companies —Metropolitan-Vickers (1) and English Electric (2). The latter are due for delivery in the record time of just over 12 months to the oilfield power station at Casabe, Colombia, and the refinery power station at Lutong.

STUDENTS AT CORYTON REFINERY

A Mobil Oil Company photograph

During December a party of students from the Sir John Cass College visited the Mobil Oil Company's Coryton refinery and were shown the various units and laboratories.

Books and Films

Automation

Details of 80 films on various aspects of automation are listed in the December issue of *Scientific Film Review*, the bi-monthly journal of the Scientific Film Association. This is claimed to be the first list of its kind and should prove a useful work of reference for managements concerned with either the technical or human aspects of the subject.

Copies, price 3s. 9d. each, post free, are obtainable from the Scientific Film Association, 164 Shaftesbury Avenue, London, W.C.2.

Tips on Talking

To many people, the thought of having to prepare and deliver an address, a technical paper, or a talk of any sort is a nightmare. For such people, and in fact for all potential speakers, the West Midlands Group of The British Association for Commercial and Industrial Education has prepared an extremely useful booklet *Tips on Talking* which will do much to produce effective speaking from those who have followed its precepts. This 16-page publication, which is illustrated by humorous drawings, can be obtained from A. M. K. Turney, Education and Training Officer, The Hercules Cycle and Motor Co Ltd, Aston Cross, Birmingham 6. Price, *payable in advance*, is 1s. 6d. per copy. If 100 copies are ordered there is a discount of 6d. per copy.

National Petroleum Bibliography

The first edition of this new bi-monthly periodical is an index of more than 400 publications, predominantly technical and trade journals, pertinent to all branches of the petroleum industry. Indexed under the Uren decimal system, it also includes details of current books, technical papers, maps, and various special publications of oil and gas agencies and institutions.

It is published in a convenient size ($5\frac{1}{2} \times 8\frac{1}{4}$ inches) and will be found a valuable reference by executives, petroleum technologists, and researchers who are desirous of keeping abreast of current petroleum literature.

A sample copy of the first edition may be obtained from National Petroleum Bibliography, Box 3586, Amarillo, Texas. The subscription rate is $35 per annum.

SNAM

This profusely illustrated book, partly in colour, tells the story of the development of The Societe Nazionale Metanodotte, SNAM (National Natural Gas Pipeline Company). Founded on 30 October 1941, with a capital of 3 million lire, the company made little progress until after the end of the second world war. The discovery of large natural gas fields in the Po Valley presented SNAM with the problem of distributing the valuable fuel to the industries of Northern Italy as conveniently and as early as possible. It was an enormous undertaking, involving the construction of an adequate network of gas pipelines which, starting from the centres of production, had to cross Northern Italy in every direction. By the end of 1955, this network covered 2470 miles, including 550 miles covered by associated companies. Its maximum capacity is as much as 875 million cu. ft. per day.

The company's address is Conso Venezia 16, Milano.

SHELL MAGAZINE No. 600

With its December 1956 *issue the* Shell Magazine *reached its* 600*th issue. First published in* 1921 *as* The Pipe Line *it had also completed* 35 *years of publication and here F. J. Stephens, a managing director of the Royal Dutch/Shell Group, pins a* 35*-year emblem on a copy. With him* (centre) *is K. B. Showler, its editor, and* (left) *B. W. Smith, head of Staff Publications, Employee Information Division, The Shell Petroleum Company, and a former editor of the magazine.*

The Ruthless One

This is the title of Shell's latest film on insect pests and is a translation of *Al Garad*—one of many Arab names for the desert locust, the perennial scourge which takes a heavy toll of crops and human happiness over vast areas of Africa and Asia.

The film starts by showing the size and nature of the locust problem as it is actually experienced in more than 60 countries ranging from the Atlantic Ocean to the Bay of Bengal. From there it proceeds to study the locust itself revealing, by specially shot close-up sequences, mating, egg-laying and hatching, the growth of the immature hoppers and their coalescence into marching bands, the emergence of the winged adults, and the formation of destructive swarms which may consume some 2000 tons of food per day.

The latter part of the film shows how information obtained from many countries is mapped and analysed by the Anti-Locust Research Centre in London, and how probable movements can be forecast so that the countries affected can be warned to prepare counter-measures in time. The film, which also illustrates research work on the insect itself, runs for about 20 minutes, and is available on loan, either in 16 mm or 35 mm, from the usual Shell libraries.

Shell have also produced an attractive booklet—*The Hungry Thief*—which deals in some detail with the problem of the desert locust.

Refinery Utilities Symposium

Electrical Power

By **W. S. MORRIS**

This is the final paper presented to the IP Stanlow Branch on 16 November 1955. Mr Morris is on the staff of the "Shell" Refining and Marketing Co. Ltd.

In discussing Electrical Power as utilized in refineries, it is perhaps as well to commence with some figures showing the amount of such power as required in some typical instances.

Refinery	*Crude input tons per day*	*kW max. demand*	*kW max. demand ton*	*Area in acres*
A	5,500	7,000	1·3	225
B	23,000	22,000	1·0	400
C	27,000	25,000	0·9	750
D	41,000	42,500	1·0	1,200
E	12,000	18,000	1·5	1,000

It is immediately obvious that many refineries must be classed as major users of electricity and, bearing in mind what has been said about steam requirements in the previous paper, it is a matter of surprise to some people that a number of refineries do in fact purchase the whole of their electricity requirements. The reasons vary in different cases but include the following:—

(a) Certain refineries had very small beginnings and the purchase of outside supply was the obvious choice as in those days steam drives predominated. As these places expanded the case for changing over to own generation was upset by the necessity of having to off-set standing charges for existing low-pressure boilers.

(b) More recently, consideration of change-over to full or part generation was abandoned because the necessary generating equipment could not be obtained in time to match up with expansion programmes while the Supply Authorities on the other hand had the facilities at their disposal.

(c) A further consideration is the fact that general policy would be to utilize available capital to the maximum extent on process units to produce more and better products which is the main purpose of an oil refinery.

Reverting to the table of typical requirements it will be seen that the amount of electricity in kilowatt hours per ton of crude input varies from approximately 24 to 36, so that it is fairly easy to make a rough estimate of cost of electricity per ton of crude input. A word of explanation is required in the case of typical refinery "E": this is a highly integrated establishment which includes a petroleum-based chemical plant. Further it includes lubricating oil and other processes which require feedstocks not available from the crude refinery.

It is interesting to use the figure of 1 kW of maximum demand per ton of crude input to make a rough calculation of the increase in U.K. refinery electricity requirements during recent years. In 1948 the crude input to U.K. refineries was of the order of 10,000 tons per day, and towards the end of 1954 this had increased to about 80,000 tons per day, so that in some 6 years U.K. refinery electricity requirements had gone up by at least 70,000 kW and probably more if an allowance was made for the associated chemical plants.

While the matter of cost must not be relegated too much into the background, the paramount requirement of a refinery electricity supply is reliability. This matter of reliability cannot be overstressed, as both process units, and the producion of other utilities can be effected, to say nothing of any hazard arising from the loss of lighting. In the case of process units which have petroleum products in circulation at elevated temperatures and rely solely on electric drives, a failure of supply upsets the circulation with the result that temperatures are liable to get out of control and set up excessive pressures, thus producing a fire hazard. Under these conditions, heater tubes can coke up and distort, their replacement being a lengthy and expensive business. Even the failure of a few pumps resulting from a transient on the supply system can upset the finely balanced operation of complex process units and result in the production of only off-grade products for periods of many hours.

Apart from process units, reliability of electricity supply is of vital importance if it is used without adequate alternatives for the production of compressed air or the supply of process circulating water. The loss of compressed air robs the process units of their controlling medium, while the cessation of cooling water would call for a crash shutdown under hazardous conditions as there would be no medium to control temperatures.

Current practice is to depend mainly upon steam for air compression and in the case of cooling water circulation to use electricity for not more than half the required circulation unless some form of water storage is available to maintain the circulation long enough to allow the process units to be shut down with the minimum of risk.

As a measure of the present-day confidence in electricity supply it should be mentioned that there are a number of all-electric process units operating in the U.K. and these include distillation units with individual throughputs exceeding 10,000 tons per day, besides gas separation and treater units. The complexities of catalytic cracking units are such, however, that they usually have sufficient steam drives to be able to carry on in spite of a failure of electricity supply.

The supply may be wholly obtained from the refinery's own generating plants, be wholly purchased, or be a combination of the two. The correct solution can only be made in the light of a particular case.

Where sole reliance is placed upon purchased power, then duplicate supplies are essential. In this connexion, it must be pointed out that a double circuit overhead line, at least up to 33 kW, does not possess an outstanding degree of reliability, as both circuits can frequently be affected simultaneously by lightning. An acceptable supply arrangement would be two or more underground feeders from a major power station which is interconnected in turn with the equivalent of the U.K. grid system.

If refinery generation is to be employed without interconnexion with a supply authority then a percentage of condensing plant will be essential in order to take up the out-of-balance between steam and electricity requirements. Electricity produced as the result of condensing is produced under the same conditions as apply to the Supply Authorities' thermal power stations and other things being equal will cost just as much. Again condensing arrangements require large supplies of cooling water which might be more profitably used on a process unit.

If an interconnexion is made between the refinery generating system and that of the Supply Authority then the former can operate entirely on back pressure turbines leaving the Supply Authority to make up any electrical deficiency. This method produces the highest thermal efficiency for the refinery's own generating plant but the tariff agreement with the Supply Authority must be agreed with care, otherwise the margin of saving derived from own generation may be seriously affected.

Refinery Applications of Electricity

The largest application is for driving pumps—mostly centrifugal—in process units, transfer pumphouses, and shipping of products.

Apart from the pumps for handling petroleum products in one form or another, the pumping of water whether for cooling, domestic, or sewage purposes provides a further usage.

Electricity is used in the workshops, canteens, offices, etc., for very much the same purposes as in any industrial undertaking.

Lighting is an essential feature, due to the continuous working.

Electricity is required for the complex instruments which indicate and control the processes and in a host of elaborate instruments and apparatus used in the various laboratories to test and maintain the quality of the refinery products. The details of such applications are however beyond the scope of this paper.

It will be noted that electricity is not used directly in any processing of petroleum such as in the electrolytic production of certain chemicals.

Distribution Within Refinery

The problems of distributing electrical power within a refinery do not differ widely from those encountered in large industrial plants. The area concerned is relatively large as can be seen from the table first quoted.

The final utilization voltages in the U.K. are normally 415 volts for small and medium sized motors and 240 volts for lighting. It is obvious then, for the amounts of power previously referred to, that higher voltages must be used for distribution purposes and also for supplying large motors. For this purpose, 3300, 6600, and 11,000 are all being used. One major organization purchases or generates its supply at 6600 volts and uses this for distribution as well as for supplying motors greater than 200 h.p. while another organization purchases or generates at 11,000 volts, which is used for primary distribution and is then transformed down to 3300 volts for secondary distribution and for supplying motors of 75 h.p. and upwards.

The merits of the two systems depend upon the particular installation.

A focal point in the electrical system will be the main switchgear at the generating station or at the intake substation in the case of purchased supply as any large-scale failure of this equipment would prejudice the whole refinery. In consequence, this switchgear, conservatively rated, should be chosen with considerable care from well proved types and be sectionalized with physical separation between the sections so that, in the event of fire or explosion on one section, the resultant damages can be limited and not prevent the early recommencement of operations. From the intake substation or generating station the distribution will normally be by underground cables. Where duplicate feeders are employed, security is increased if these feeders can be laid over different routes. These primary feeders are usually laid in the verges next to the roads. Ducts are provided for cables crossing roads, railways, or pipetracks, but elsewhere the cables are buried direct in the ground unless acid or alkaline contamination exists or is expected in which case a concrete trench through the affected area is provided. The large-scale use of ducts is avoided due to their ability to transmit vapours or liquids. The primary feeders will terminate in smaller substations, placed as near as possible to larger load centres.

It is quite obvious that electrical apparatus which can produce arcs and sparks cannot be placed in the midst of petroleum equipment which can give rise to inflammable vapours. This is a problem which comes up during refinery design and is then continually with the operating staffs as any ignition may have disastrous consequences. To overcome this risk, the alternatives are usually as follows:—

(1) Site any electrical apparatus which can cause arcs or sparks outside any area in which inflammable vapours can occur.

(2) Employ electrical apparatus which is specially designed to operate in surroundings where inflammable vapours may be present.

Each of the above alternatives can be split into special categories, but these can only be dealt with superficially in this paper. The subject is dealt with comprehensively in the *Electrical Code* of The Institute of Petroleum.

It is further obvious that the first alternative cannot be applied to motors, lighting equipment, and electrically

operated instruments as these must be used in what will be termed from here onwards as "Dangerous Areas." However, with good design, it is possible to have substations and switchhouses sited outside the dangerous areas and this is beneficial in that it allows the use of standard industrial apparatus.

Electrical apparatus which is designed for use in areas that are classed as dangerous is usually of the class possessing a flameproof enclosure. The full definition of "flameproof" is rather technical but it may be summarized as applying to an enclosure which is capable of withstanding an internal explosion arising from the ignition of any inflammable vapours which are inside; further, that any products of the explosion that escape are in such a condition that they will not ignite any inflammable vapours surrounding the enclosure. BS 229 gives further technical details of construction.

It is hardly necessary to say that flameproof apparatus is massive and expensive, and requires careful maintenance if the quality of flameproofing is to be kept throughout its life, hence its use is avoided wherever practicable.

A further class of electrical apparatus, which can be used where inflammable vapours may be present, is covered by the term "Intrinsically Safe" but, as the fundamental requirement of such apparatus and their circuits is that any sparking in normal working is incapable of causing ignition, the practical application is limited to instrument and alarm circuits.

While motors of up to 1000 h.p. and at voltages up to 6600 volts can be obtained as flameproof, it is impracticable to obtain flameproof switchgear above 3300 volts and then only with a limited short circuit performance. As the primary distribution is usually at higher voltages, the aim to site substations outside any dangerous areas will be appreciated. Apart from the equipment problem maintenance work outside the dangerous areas can be carried out with less restriction.

Reverting to the local, or plant, substations these are usually of the indoor type and comprise high tension metal-clad switchgear in the ranges 3300, 6600, or 11,000 volts, and low tension metal-clad switchgear of 415/240 volts. In the U.K. the transformers can be located outdoors adjacent to the substation. If security of supply is essential then the sub-division of the switchgear by fire walls will be required. Circuit-breakers will usually be of the oil immersed types as these are less susceptible to atmospheric attack than air break patterns.

At these substations, the lighting supplies will usually be separated from the purely power supplies and separate power and lighting feeders will be taken to process unit or pumphouse switchrooms by underground cables—again in duplicate and over separate routes if security demands.

Process Unit Electrical Installation

The final stage of utilization, namely the process unit, has now been reached. Its electrical apparatus will largely comprise motor-driven pumps and heater fans, lighting equipment, and the electrical apparatus of the control room. The motors will almost inevitably be flameproof and of the squirrel cage type arranged for direct-on-line starting. The tendency for process unit centrifugal pumps to operate at the maximum speed of 2900-3000 rev/min is noteworthy. Prior to the recent refinery expansion programme, motor manufacturers had little experience with large high-speed flameproof motors and certain teething troubles had to be overcome, particularly in the matter of bearings. One of the advantages of the high speeds, however, is their inherent high power factor.

Starting equipment except in the case of very small motors will usually be grouped in a switchroom located so that industrial equipment can be used—individual starters being remote controlled from flameproof stop-start push button and ammeter units mounted adjacent to the motors.

The ability of the squirrel cage induction motor to operate continuously for periods of up to two years or more between maintenance inspections has been responsible for its increasing use despite its being able to operate at one speed only.

The connexions between motors and their control gear is usually effected in paper or rubber insulated cables, lead covered, and then armoured with wire or steel tape. The cables are laid in trenches formed into the concrete floors, covered with sand and then floated over with weak concrete.

Although conduit was once used extensively for the lighting wiring, this has given way to rubber or P.V.C. insulated cables, lead covered, and steel wire armoured. The use of such cables avoids the troubles which arise due to condensation within conduits.

Acid or caustic areas call for special treatment and in these cases the cables are preferably run overhead. To prevent corrosive attack of the armour or lead sheathing, it is now almost standard practice to have an extruded P.V.C. sheath over the armour instead of bitumen impregnated hessian as previously.

The lighting installation will comprise flameproof lighting fittings up to 300 watts for tungsten lamps and 80 watts for fluorescent. In so far as certain parts of process units are well above ground level and are fully exposed, the necessity to use flameproof lighting equipment above a certain level will sometimes be questioned, particularly as petroleum vapours are, with few exceptions, heavier than air. The use of vapour-proof lighting facilities may in these circumstances be justified.

Pumphouse lighting should have an intensity of not less than 10 ft candles since good permanent lighting obviates the use of portable handlamps. Handlamps of the battery type similar to those used in the mines have a relatively poor light output and require daily charging. Handlamps supplied from the mains even at low voltages are not absolutely free from risk in a dangerous area and their use is better avoided altogether.

Sufficient area lighting must be installed to allow operators to move about quickly without risk. Local lighting has to be provided over gauges and instruments, so that these can be read without any other aid.

The illumination of higher elevations must be designed primarily with an eye to the safety of operating personnel —this means particular attention to stairways and landings. The result is often rather spectacular and can have some publicity value.

The nerve centre of any process unit is its control room and little effort is spared in providing first class illumination at this point. Directional illumination of the control panel is usual and intensities of 15/20 ft candles in the vertical plane are in use with a lower level of 10 ft candles over the remainder of the room.

While the duplication of internal distribution etc. can go a long way to remove the risk of total failure of lighting, local emergency supplies from automatic starting diesel or steam generators is sometimes provided, so that operating staff will not have to close down a complex unit in total darkness. In certain key process units, *i.e.* catalytic cracking, the arrangements are such that the emergency generators can also take over the supplies required for instrumentation.

Finally, reliability, which has been frequently referred to in the foregoing, is not achieved by the wholesale application of complicated apparatus; expericence indicates that rugged simplicity in itself has a large measure of reliability.

Acknowledgment

The author wishes to express his thanks to the management of Messrs "Shell" Refining and Marketing Co Ltd. for permission to publish this paper and for advice and help in its preparation.

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Petroleum in Parliament

Oil Supplies

On 3 December, the Minister of Fuel and Power said that the British oil companies were informed some time ago that there was no objection to their purchasing supplies of oil from the U.S.S.R. A number of small-scale commercial offers had been received and accepted. Such offers were usually made f.o.b. at Black Sea ports.

In reply to supplementary questions, the Minister said that every effort was being made to supplement the supplies of oil arriving in the U.K. from the Middle East via the Cape. The British oil companies were collaborating fully in this effort, said the Minister, and had already succeeded in obtaining additional supplies from Western Hemisphere sources and elsewhere.

The Minister also said that the oil companies had already bought some cargoes from Pemex, and they could, he felt sure, be relied upon to negotiate promptly with the Mexican oil authorities for other quantities on offer.

In regard to the shortfall in U.K. oil supplies, the Minister stated that this was likely to be about 25 per cent.

U.K. Oil Production

In reply to a question concerning oil production, the Minister said that prospecting in the U.K. was now being undertaken on a greater scale than ever before, and promising discoveries were made in 1955 in the Egmanton area of Nottinghamshire, though it was too early to assess the reserves in this field. Altogether, said the Minister, 120 oil prospecting and mining licences had been granted covering over 20,000 sq. miles. Output for 1956 from the 230 wells now producing was expected to exceed 60,000 tons.

Oil Tankers

In a written reply on 10 December, the Minister of Transport and Civil Aviation said that a fleet of tankers of about 7 million deadweight tons would be needed to meet normal demands, if all the oil normally imported into the U.K. from the Middle East was routed via the Cape.

The present fleet of tankers available for this purpose, including many foreign ships on charter, probably totalled under 5 million deadweight tons. The best short-term means of making good the loss of tanker capacity resulting from the haul round the Cape was by transferring tankers to shorter voyages, especially those across the Atlantic, as was now being done. The Minister said that steps had also been taken to speed the repair and turn-round of tankers during the present shortage in order that the greatest possible use could be made of existing ships.

Hydrocarbon Oil Duties

On 10 December, in the Second Reading of the Hydrocarbon Oil Duties (Temporary Increase) Bill, the Chancellor of the Exchequer said that the Excise duty on indigenous oils, such as those produced from coal and shale, would be raised from 1s. 3d. to 2s. 3d. a gallon. (For duties on other oils *see* page 3 in last month's issue).

Middle East Oil Pipelines

On 10 December, the Minister of Fuel and Power said that the Iraq Petroleum Company had already carried out a reconnaissance of a possible pipeline route from the oilfields of Northern Iraq through Turkish territory to the Mediterranean seaboard. He understood that the results of this reconnaissance were favourable.

On 17 December, the Minister of Fuel and Power said that plans were under consideration for the expansion of existing Middle East pipeline capacity by about 40 million tons a year. He also said that further measures for reducing the dependence of Western Europe on the Suez Canal by providing alternative means for the transport of oil were being studied. It was not at present possible to forecast the time required to complete these schemes.

Kuwait Oil Installations

In a written reply on 17 December, a Joint Under-Secretary of State for Foreign Affairs said that between 10 p.m. on 10 December and 2 a.m. on 11 December nine explosions occurred among oil installations belonging to the Kuwait Oil Company (which is owned half by British and half by American interests). The explosions occurred at three oil wells, in the area of an underwater pipeline, and on a gas pipeline to the town of Kuwait. There were no casualties and damage was minor except in the case of one well at Ahmadi where the fire was extinguished on 14 December. The effect on oil production was negligible. This almost wholly unsuccessful sabotage was carried out under cover of very stormy weather conditions.

PERSONAL NOTES [*Continued from page* 44]

Board, in charge of marketing, has been appointed general manager (administration) of Shell-Mex and B.P. Ltd. He succeeds **A. L. King,** A.C.C.A., F.R.S.S., M.Inst.Pet., who will become general manager (sales) on the retirement of **A. M. Mackintosh** at the end of March.

Mr Durie joined Shell-Mex and BP Ltd in 1933 and has held appointments in Southampton, Leeds, Liverpool, Leicester, and London. In 1950, he was appointed manager of the Company's Retail Marketing Department at Head Office and, in 1952, on the retirement of **A. R. Rodway,** succeeded him as London divisional manager, a position he held until his departure for Australia in 1954.

Petroleum Equipment Manufacture in Italy

Two rings of one of two towers under construction for a Middle East oil company. Each tower will be 22 ft diameter, 144 ft high, and will weigh about 420 tons.

Originally known as Costruzioni Impianti Metallici Edili (*Metallic Building and Plant Constructors Inc*), the Guido Sartori Company of Porto Marghera, Venice, is among the leading Continental companies engaged in the construction of petroleum refineries and similar plants. The change of name took place soon after the second world war and coincided with the start of a considerable expansion.

To-day the Company has a staff of about one thousand artisans, about one hundred draughtsmen, together with engineers and technicians. Covering an area of over 100,000 square yards the Porto Marghera, Venice, works are well equipped for the manufacture of petroleum refining and similar equipment.

Present production capacity is about 4000 tons monthly and plant can be fabricated in a wide variety of metals, alloys, and cladded materials up to 6 inches in thickness and limited in size only by transport facilities.

Among the plant available in this factory is a special prespun press built under licence from Messrs Daniel Adamson & Co Ltd, of Dukinfield. On that machine, dished, flanged, elliptical, and hemispherical heads can be

The mobile stress-relieving unit.

turned out by hot-rolling to diameters of up to 16 feet and in thickness up to 6 inches. Plant is also available for hot or cold rolling of plates up to 15 feet wide and 6 inches thick.

For on-site erection, the Company has a wide variety of transportable equipment, such as welding machines, compressors, derricks, and cranes, together with mobile workshops and pipe-fitting gear. A special piece of movable equipment is a stress-relieving furnace which can be broken down into sections for easy transport. This furnace, which can accommodate vessels up to 30 metres long, is very valuable for the annealing on site of vessels which are too large for assembly in the shop.

The manufacture of the actual refinery equipment is carried out in collaboration with an associated company, the Construzioni Impianti Petroliferi Industriali (CIPI), while Messrs Guido Sartori undertake the general erection work with its own means and personnel. Thus, Sartori has been employed in most Italian refineries and has erected practically every type of plant.

While the Company collaborates with Italian and the international designers of petroleum refining equipment, it also has its own design staff. It also works to the codes set up by various bodies, such as the API, ASME, Lloyds, DIN, etc.

In addition to its work in Italy, the Company has built up a considerable export business and its products are to be seen for example in the Middle East, the Argentine, Belgium, Holland, and the United Kingdom.

Recently R. Rolo, the personal representative in the U.K. of Guido Sartori, has formed a new organization (Rolo Engineering Co Ltd) to act as agents for CIPI.

Recently a reception was held in London for Mr Sartori who is seen here (second from left) *with R. Sims (Caltex Services Ltd), B. G. Banks (Trinoil (U.K.) Ltd), and Lt.-Col. S. J. M. Auld (Alco Products Export Co).*

Forthcoming Meetings

THE INSTITUTE

(At 26 Portland Place, London, W.1, 5.30 p.m.—tea 5 p.m.)

Trends in Exploration Methods. H. R. Warman, M.A., and A. T. Dennison, B.Sc., Ph.D. **6 March**

IP FAWLEY BRANCH

(At Esso (Fawley) Recreation Club, Holbury, 7.30 p.m.)

The Effects of the Beaver Report on Pollution. P. Laister, B.Sc.(Tech.) A.M.C.T. **8 March**

IP LONDON BRANCH

(At 26 Portland Place, London, W.1, 6 p.m.—tea 5.30 p.m.)

Atomic Energy. I. Wells, B.Sc., M.I.Chem.E. **27 February**

Training and Selection of Staff. R. S. Butler, B.Sc.(Econ) **25 March**

IP NORTHERN BRANCH

(At Engineers' Club, Albert Square, Manchester 2, 6.30 p.m.)

Paper to be announced, followed by **Annual General Meeting** **19 February**

Transmission Systems for Road Vehicles. D. J. K. Stuart. **19 March**

IP SCOTTISH BRANCH

(At North British Hotel, Edinburgh)

Joint Meeting with the Scottish Section of the Institute of Fuel.

Address by J. G. Annan. **21 February**

(At BP Refinery Recreation Hall, Grangemouth)

Petroleum Fuels for Domestic Heating and Lighting. G. F. J. Murray and D. G. Tompkins. **21 March**

IP SOUTH-EASTERN BRANCH

(At King's Head Hotel, Rochester, 7.45 p.m.)

Oil and Energy. M. E. Hubbard.

Film: *Willing Workers.* **5 March**

(At Medway College of Technology, 7.45 p.m.)

Joint Meeting with the Royal Institute of Chemistry. **21 March**

IP SOUTH WALES BRANCH

(At Training Centre, BP Refinery (Llandarcy) Ltd, 5.30 p.m.)

Explosion Hazards Associated with Oil Mists and Suspensions. Professor D. M. Newitt, M.C., Ph.D., F.R.S. **7 March**

IP STANLOW BRANCH

(At Grosvenor Hotel, Chester, 7.30 p.m.)

Joint Meeting with the Institute of Fuel.

Nuclear Energy. F. M. Greinlees, B.Sc., M.I.E.E., M.I.Mech.E., A.M.I.C.E. **21 February**

Joint Meeting with the Royal Institute of Chemistry

Colour Photography. H. Baines, D.Sc., Hon.F.R.P.S., F.R.I.C. **27 February**

Epikote Resins, their Properties and Applications. G. Swift, D.Sc. **20 March**

(At Lobitos Refinery, Ellesmere Port.)

Dinner Dance **29 March**

OTHER SOCIETIES
ROYAL SOCIETY OF ARTS

(At John Adam Street, Adelphi, London, W.C.2, 2.30 p.m.)

Modern Detergents. F. C. Harwood, B.Sc., F.R.I.C., M.I.Chem.E., F.T.I. **20 February**

Synthetic Detergents—A New Pollution Problem. B. A. Southgate, C.B.E., Ph.D., D.Sc., F.R.I.C. **27 February**

SOCIETY OF CHEMICAL INDUSTRY—CHEMICAL ENGINEERING GROUP

(At 14 Belgrave Square, London, S.W.1)

Joint Symposium with Société de Chimie Industrielle

Recent Developments in Fractionating Columns for Vacuum and Atmospheric Distillation. (Date to be announced)

THE SOCIETY OF INSTRUMENT TECHNOLOGY LTD

(At 26 Portland Place, London, W.1., 6.30 for 7 p.m.)

Joint Meeting with Control Section.

Some Considerations in the Control of Pressure. S. T. Lunt, B.A., I. Gray, B.Sc., and A. J. Southern. **26 March**

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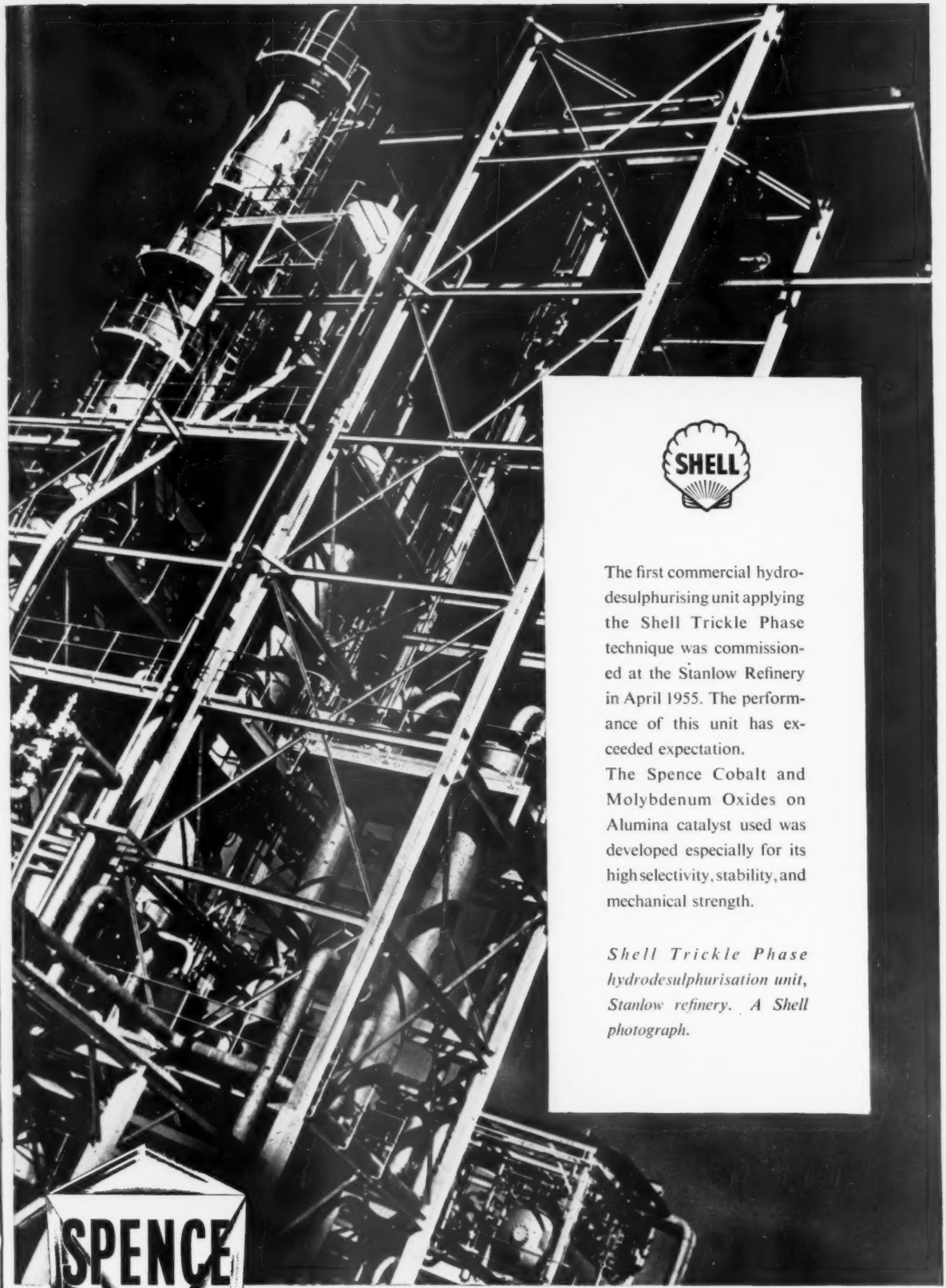

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Shell Trickle Phase hydrodesulphurisation unit, Stanlow refinery. A Shell photograph.

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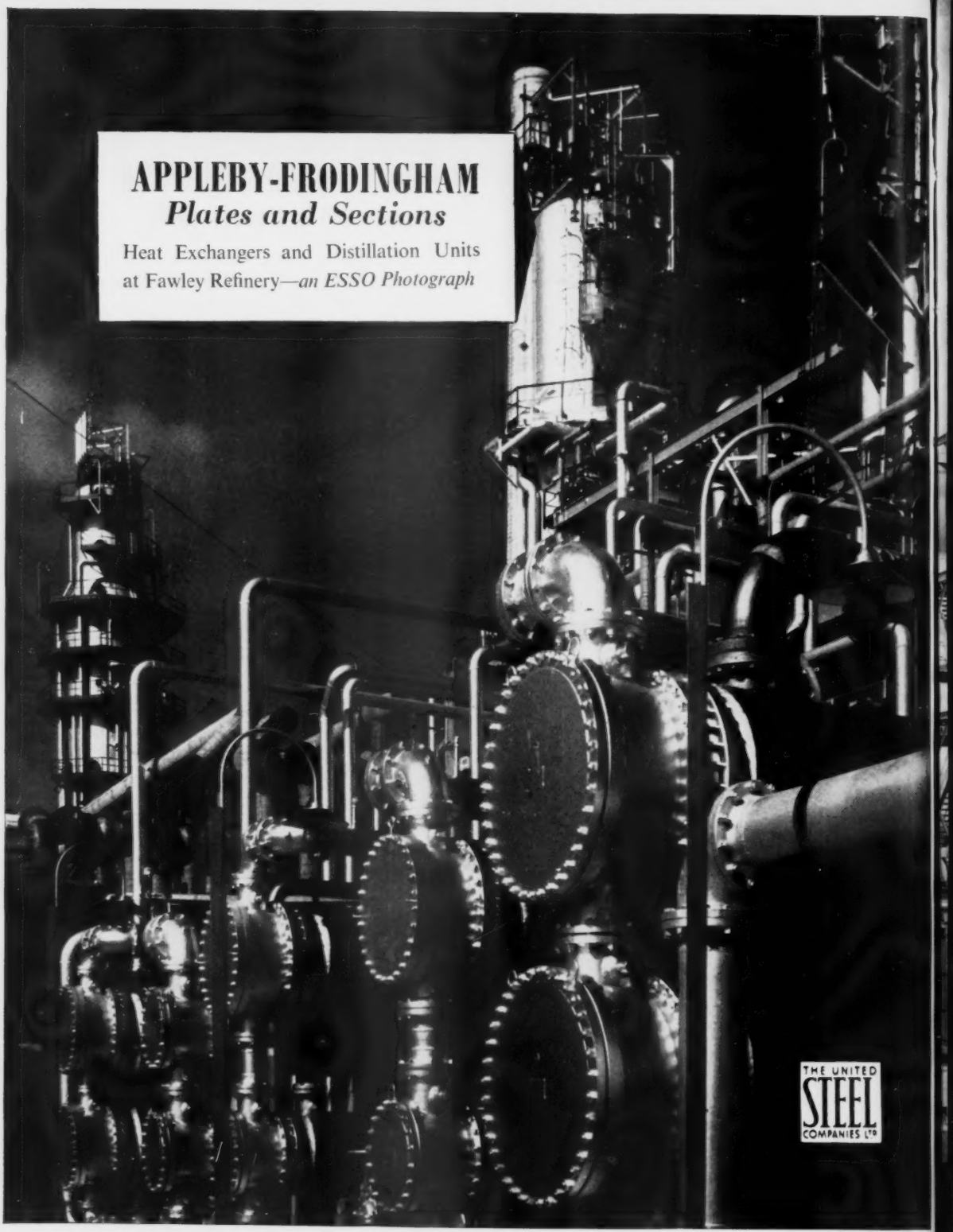

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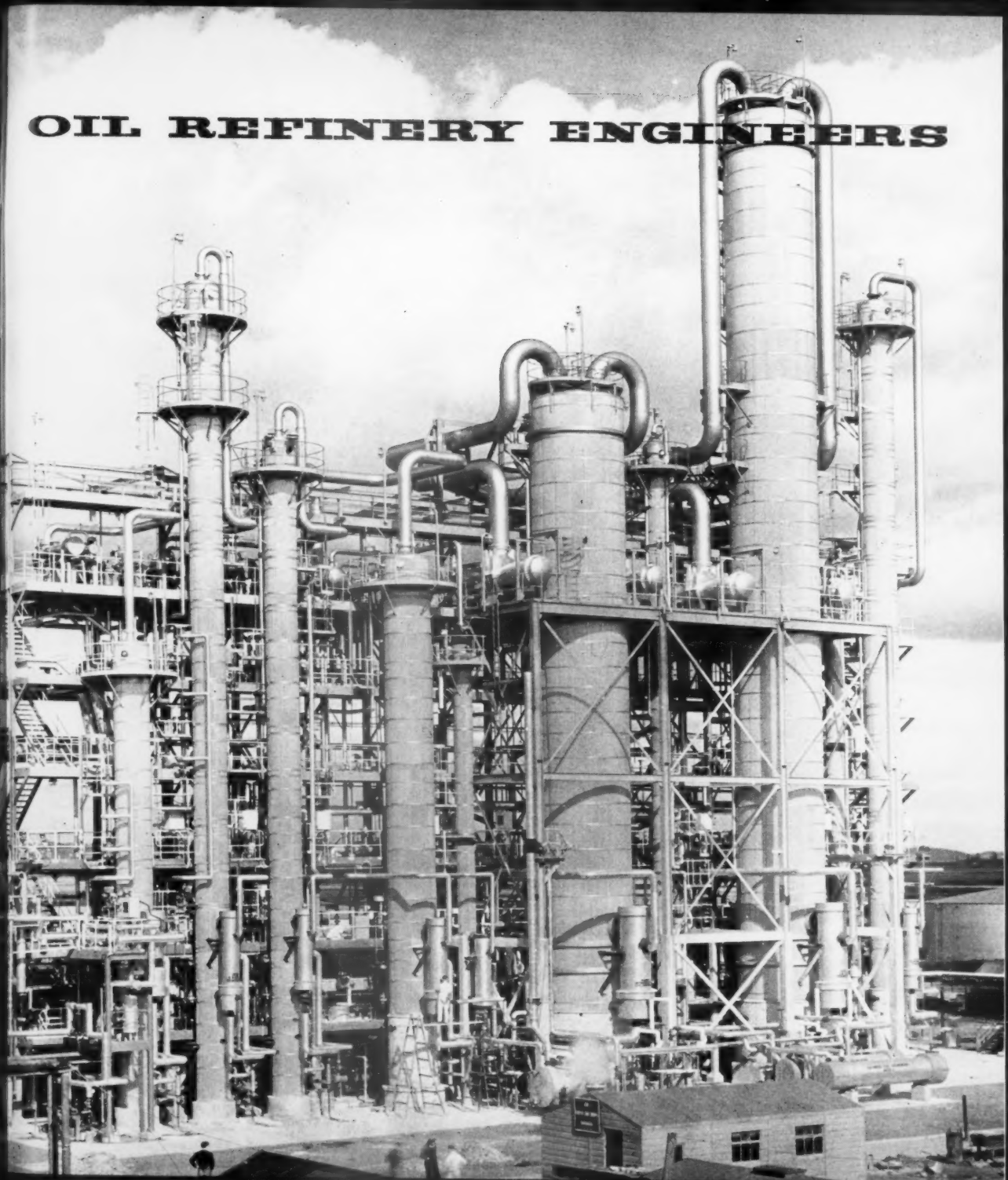

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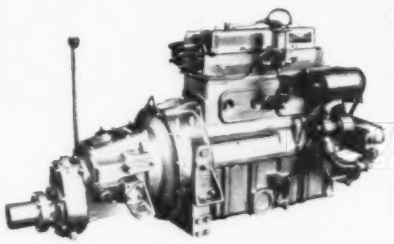

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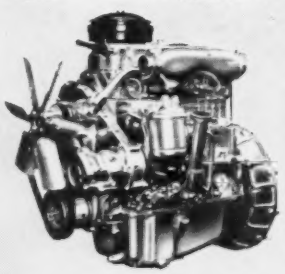
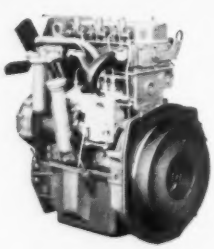


P4 (I) Industrial Diesel Engine



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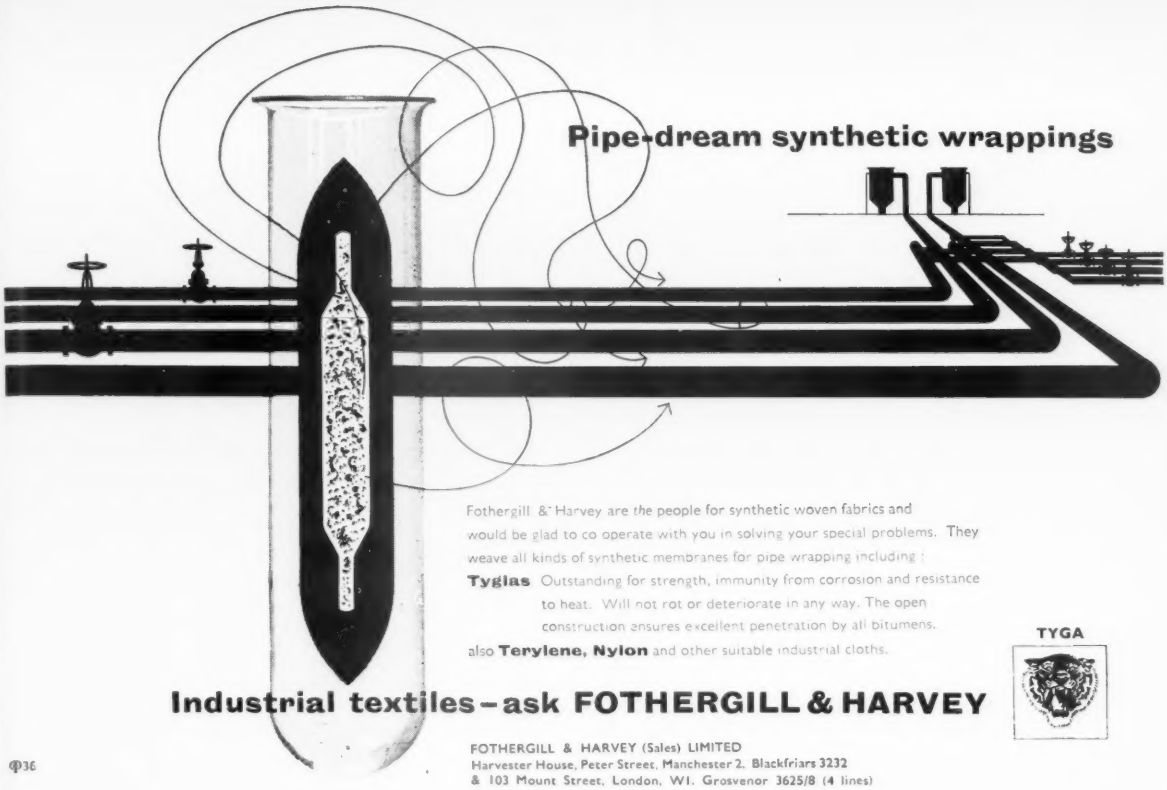

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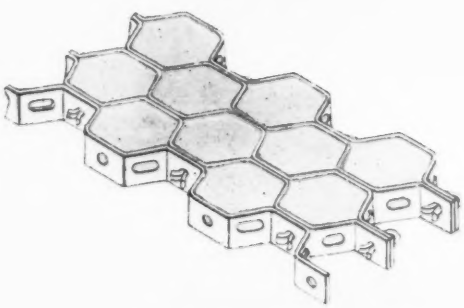

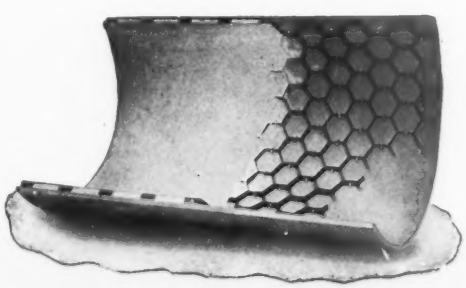

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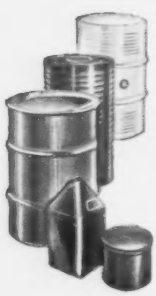

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